

The Blast Furnace *and* Steel Plant

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Don't Neglect the Practical Man

SIR WILLIAM ELLIS, in his presidential address before the British Iron and Steel Institute, said that actual plant problems are being ignored by the writers of technical articles.

The man whose job it is to keep the clinkers off of side-walls, the man responsible for the consistent charging of the furnace burden, or he who regulates the dampers on a bank of soaking pits isn't interested in or helped by a highly technical discussion of the Einstein theory of relativity, or an analysis of the inter-reactions of electrons. What he would like to know is how his daily job can be done better and with less effort.

Practical plant problems and their solutions, knowledge of what the other fellow is doing and the nature of the equipment furnished him to do it with, should carry a message not only to the actual practical worker, but equally to the practical executive, whose co-worker he is.

Contact with the practical man and his point of view spells success throughout an organization, and its absence is a danger sign.

Completely Modern Indian Furnaces

Notwithstanding Low Cost Labor, Modern Mechanical Appliances Have Justified Their Adoption

ARTHUR G. M'KEE & COMPANY, Engineers & Contractors, Cleveland, who designed and supervised the construction of the two blast furnaces of The Indian Iron & Steel Company, Ltd., have just received a number of photographs of this plant, which is located at Asansol, India, about 120 miles northwest of Calcutta. These pictures, in addition to showing the blast furnaces and coke plant, also give an idea of the surrounding country, the type of labor employed at the plant, and the different style of native costume, indicating the caste of the workman.

Although situated in the Far East, the plant is typically modern in design and equipment, the only deviations being those required by topographical and climatic conditions. Practically all of the steelwork, castings and machinery were shipped from the United States and erected by native labor under the supervision of American engineers.

Heretofore, builders of iron and steel plants in the Far East have been inclined to take advantage of the cheap labor and dispense to a considerable extent with labor-saving equipment. In this instance, however, it was contended by the engineers that in view of the trying weather conditions, such as temperatures of 120 deg. in the shade, excessive humidity and torrential rainfall sometimes as great as 15 inches in a few hours, labor could not reasonably be expected to render the efficient and dependable service necessary to keep the furnace plant in full operation at all

times. The furnace units, therefore, were made of orthodox American design and construction with a maximum of mechanical labor-saving equipment. This has made it possible for the plant to be operated with a comparatively small force of the more intelligent men, and the results obtained fully justify the original plan.

The blast furnaces have already proven their ability to produce a daily tonnage exceeding 450 tons, and as the ore mines are more fully developed and transportation problems are solved, it will easily be possible to increase the output of each unit to an average of 500 tons per day or more. Both furnaces were in blast early in 1924, and due to the exceedingly low cost of assembling materials and to their excellent quality, the Indian Iron & Steel Company has been able to profitably market iron in practically all parts of the world.

India possesses enormous deposits of high-grade ore, the total reserves being estimated at 20,000,000,000 tons. The mines of the Indian Iron & Steel Company, Ltd., are located approximately 200 miles distant from the furnace plant at Asansol, to which point the ore is carried by a railroad built in part by the same company. The ore, which is soft shale-like hematite, is extremely rich in iron content, running as high as 69 per cent metallic iron and averaging 60 to 65 per cent with an average phosphorus content of .10.

The site at Asansol was selected on account of its

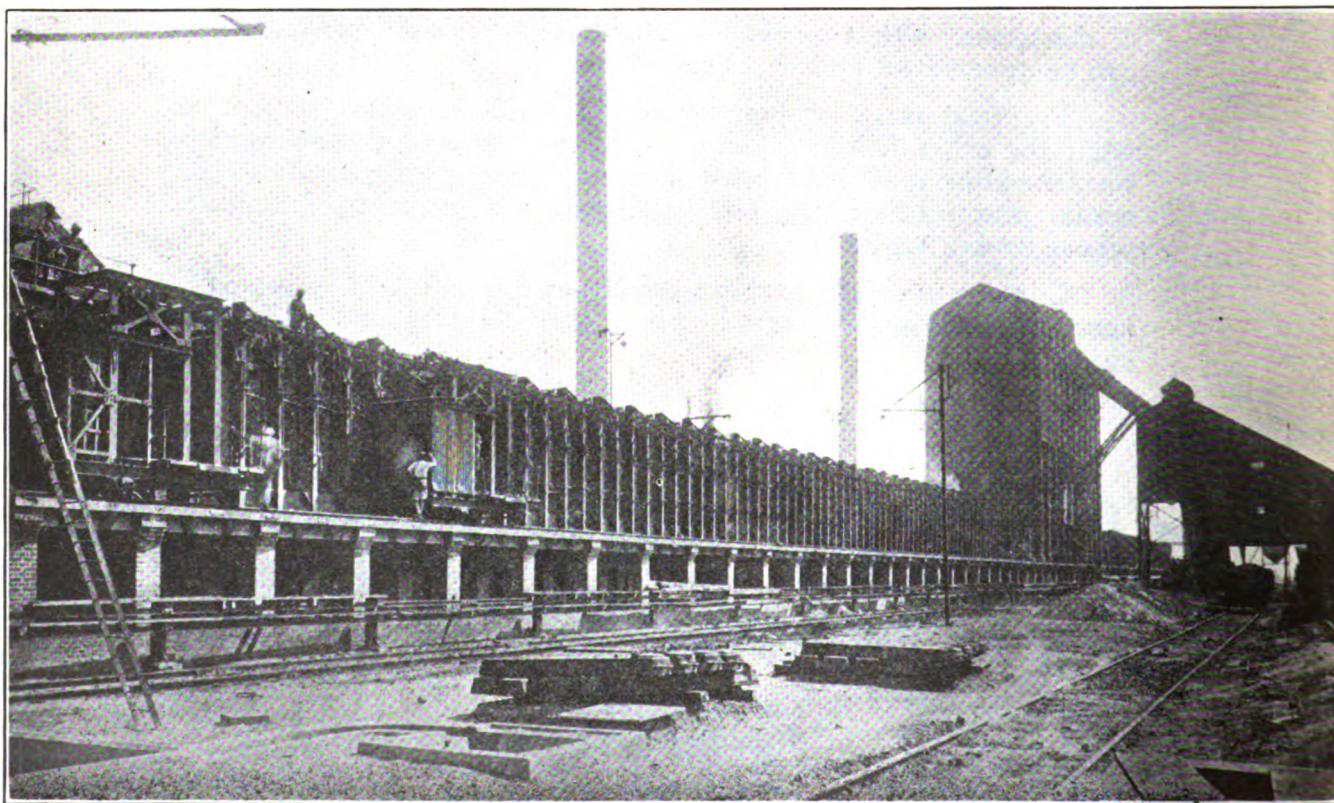


FIG. 1.—The coke ovens consist of two batteries of 80 each Simon-Carves by-product ovens.

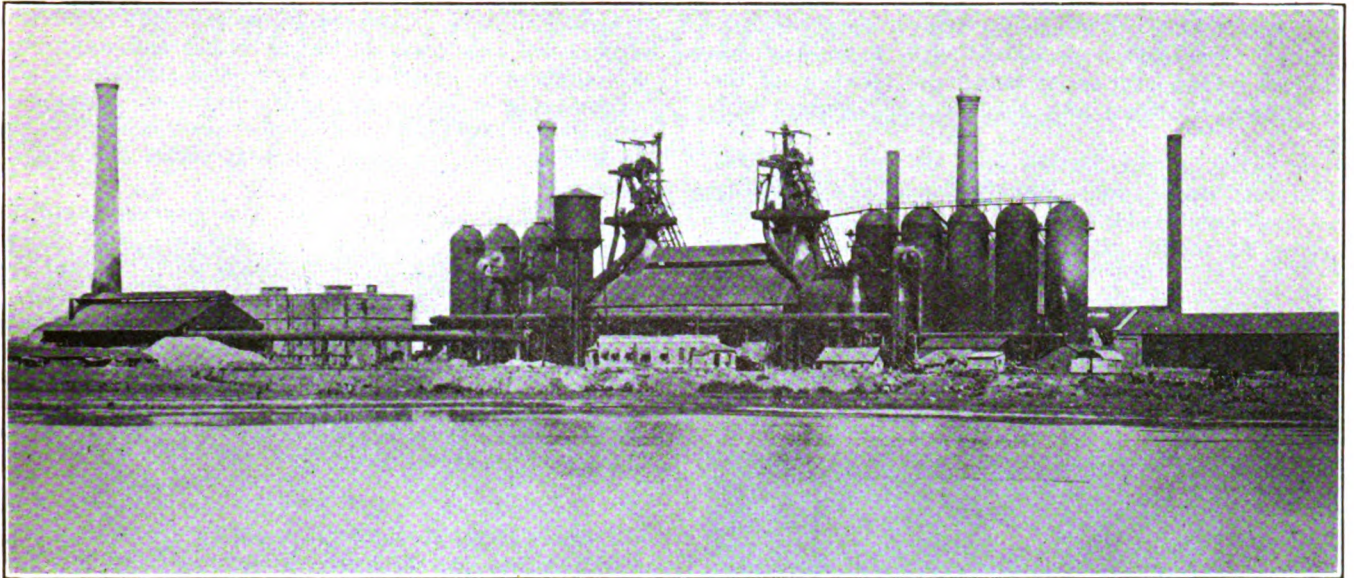


FIG. 2.—Birdseye view of entire plant.

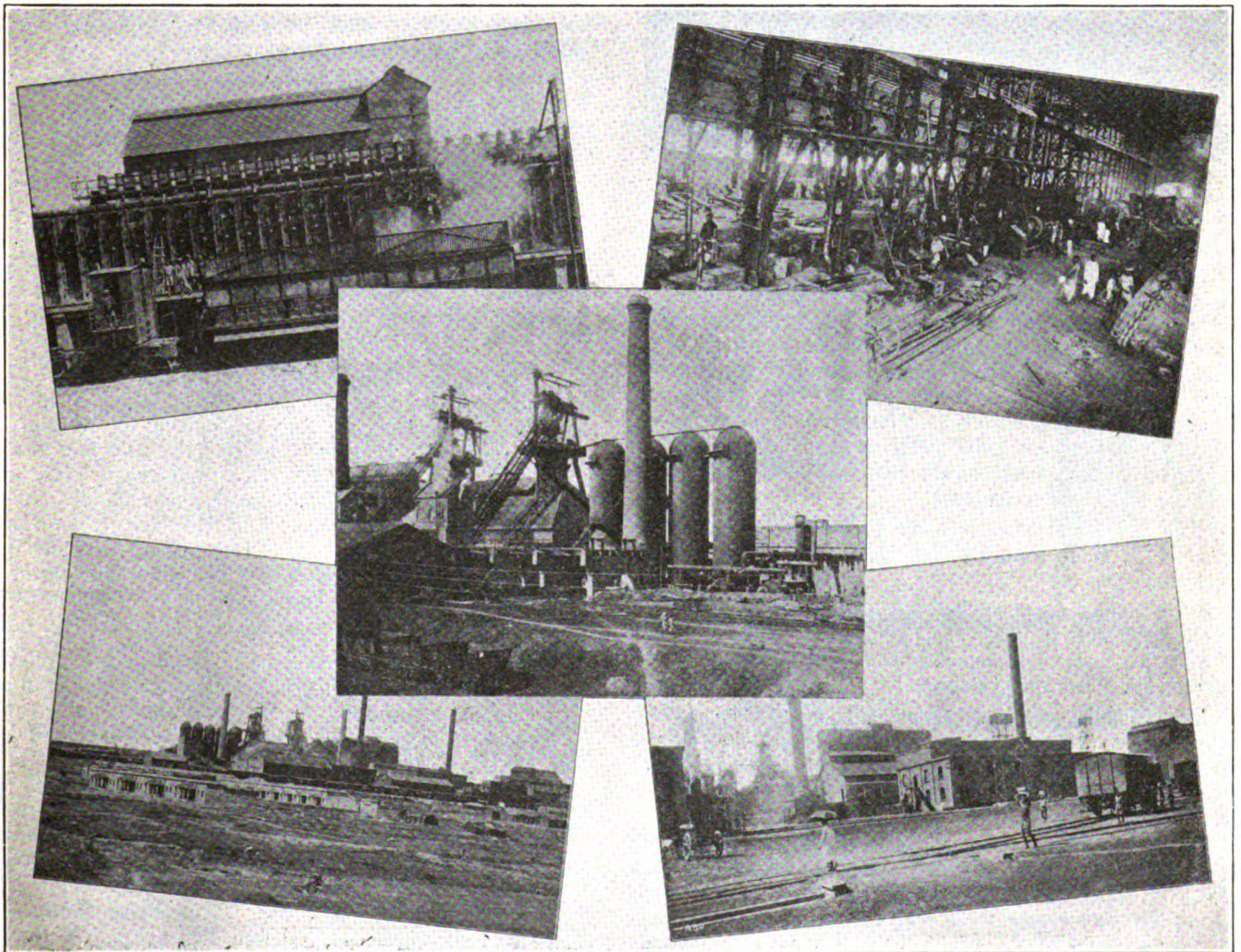


FIG. 3.—Upper left—Coke ovens and quenching car. Upper right—Interior of machine shop. Center—Close-up of furnaces and stoves. Lower left—View showing general character of surrounding terrain. Lower right—General view showing native workmen, type of freight car, etc.

proximity to the coal mines and to the Domoodar river, from which an abundant water supply is obtainable. Asansol is also excellently located as regards rail transportation, it being the junction of the East Indian Railroad and the Bengal-Nagpur Railway.

The plans of the Indian Iron & Steel Co., Ltd., contemplate the ultimate installation of six blast furnaces, sufficient coke plant capacity to provide fuel for these furnaces and the later addition of an open hearth and steel mill plant. Coke for the first two furnace units is produced in two batteries of Simon-Carves by-product ovens, each battery consisting of 80 ovens. The coke plant is shown in Fig. 1.

The blast furnaces are 80 ft. in height with 14 ft. by 6-in. hearth diameter and 19 ft. bosh. There is

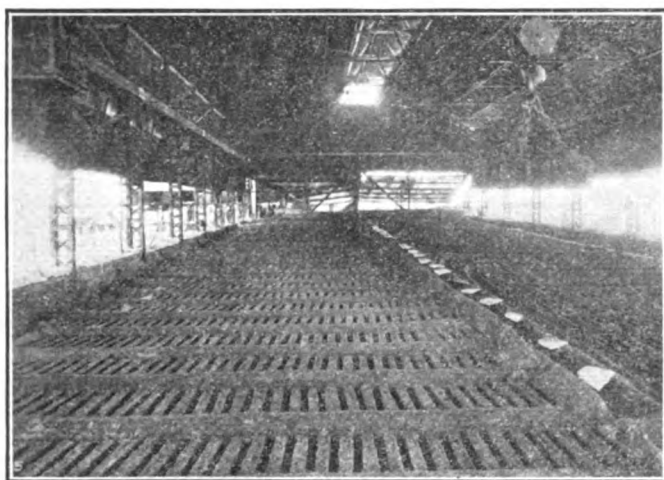


FIG. 4.—Interior of cast-house which serves both furnaces.

ample room, however, for relining to 18 ft. hearth and 22 ft. bosh. The furnaces have double skip hoists and are equipped with McKee Revolving Distributors.

Due to local conditions, it was decided to install a tunnel system for handling the ore from the trestle to the skip cars, the trestle structure being covered with a steel roof. Underneath the trestle is the scale car tunnel, the roof of which is composed of a series of unit bin bottoms provided with a continuous line of segmental type gates which can be easily operated from the scale car platforms.

Nine hot blast stoves were provided for the two furnaces, 25 ft. in diameter by 95 ft. high, with $7\frac{3}{4}$ -in. checkers.

Both furnaces are served by a common cast house which is shown in Fig. 4. Provision was also made for machine cast pigs and a double strand pig machine was installed for this purpose.

The furnace plant contains all auxiliaries necessary to make it complete in every respect, including foundry, machine shop, blacksmith shop, storage buildings, etc. The interior of the machine shop is shown in Fig. 3.

The problems in the construction of a blast furnace plant in India are vastly different from similar work in the United States. In preparing the site at Asansol, which was originally a rolling plane, it was necessary to dispose of approximately 100,000 cubic yards of excavation, which was practically all done by hand. The earth was carried away in baskets on the heads of women laborers, who also carried brick and other ma-

terials entering into the construction of the furnaces. An unusually large construction crew was required on account of the fact that the native of India cannot do as much or as efficient work as the sturdier laborers of America. This is due to the extreme climatic conditions, a vegetable diet almost exclusively of rice, lack of physical stamina, peculiar social and religious customs, etc.

However, in spite of all the adverse conditions mentioned, and the further disadvantage of erecting equipment at a point over 10,000 miles distant from its origin, the Indian Iron & Steel Company, Ltd., has completed the first step of a program which, when finally consummated, will place them among the leading iron and steel-producing companies of the Far East. Burns & Company, Ltd., are managing agents of the Indian Iron & Steel Company, with G. H. Fairhurst as managing director.

The Celite Products Company, Chicago, has just published a new bulletin (B-8d) on "The Insulation of Industrial Furnaces and Ovens." This bulletin contains new and interesting information on the methods of insulating various types of furnaces and the fuel savings which can be accomplished. A new blueprint set for engineers has also just been completed, including charts on conductivity and drawings showing the methods of insulating various types of equipment. A new bulletin on "The Insulation of Boilers" is also available.

Paul F. Hermann, one of the managers of the internationally known German metallurgical magazine, "Stahl und Eisen," has established his own business at 501 Century Bldg., Pittsburgh, Pa. Besides being representative of "Stahl und Eisen," and therefore the German Iron and Steel Institute, he is also the representative of other important German technical and scientific societies as well as publishers. Any German technical book can be delivered by him.

The National Federation of Iron and Steel Manufacturers state that the production of pig iron in the United Kingdom in June amounted to 607,800 tons, compared with 650,900 tons in May and 692,900 tons in June, 1923. The number of furnaces in blast at the end of the month was 185, a decrease of six since the beginning of the month, and the lowest number in blast since January, 1923. The output of steel ingots and castings amounted to 651,500 tons, compared with 809,700 tons in June last year.

Experimental work by the American Department of the Interior metallurgists on reduction of iron oxide by carbon monoxide is progressing rapidly at the Northwest experiment station of the Bureau of Mines at Seattle, Wash. Reduction tests have been made at temperatures varying from 700 deg. to 1000 deg. C. at times from 1 hour to 5 hours on sizes up to 2 in. Preliminary observations indicate that size has more influence than any other factor on rapidity of reduction. A piece 2 in. in diameter was not completely reduced at 900 deg. C. in 5 hours. Magnetite reduces only about half as fast as dense hematite. A new and apparently accurate method has been developed for the determination of metallic, ferrous, and ferric iron in the same sample.

European Producer Practice

Gas Operated Furnaces Reward Engineers in Search for Economies

By C. H. S. TUPHOLME*

THE European steel industry has never before been faced with such grave problems as now confront it. Quite aside from labor difficulties and exchange fluctuations, not to speak of the low ebb of constructional work, there is the always insistent demand for fuel economy. Many steel plants in Britain, for instance, consume 3,000 tons of coal per week and more, and estimating the wastage of this fuel as low as 25 per cent, this means a loss of over 100 tons of coal per day. The coal-fired furnace is, of course, the simplest in construction, but the chief effect of the demand for fuel economy has been the gradual development in Europe and extended use of producer gas-fired furnaces in the steel industry.

Steel manufacturers are quickly appreciating the advantages of producer gas-fired furnaces, chief of which are: 1, Central generation of the gas; 2, Fuel economy; 3, Complete temperature control; 4, Ease of operation. Engineers in charge of plant in works of moderate size are recognizing now that the increased cost of gas-fired installation is quickly repaid by the saving in fuel, and even to those who only use a single furnace the question has proved to be well worth serious consideration because it is often possible to install a combined gas producer and furnace in the space previously occupied by a coal-fired furnace.

It is, of course, obvious that if the combustion of the fuel is carried out in two stages, the first being the gasification of the fuel in the producer and the second the combustion of the gas in the furnace, the initial cost of the plant must be higher than if combustion is completed in one stage. On the other hand, very often one producer will supply gas to a battery of furnaces, and as the latter can be built more compactly and quite as cheaply as equivalent coal-fired furnaces, in this case the additional cost of the gas-fired system is not a large item. In any case, the general experience is that the capitalized value of the saving in fuel and wages will very quickly pay for the increased cost of the plant.

So much for the reason why producer gas-fired furnaces are popular in Europe. I propose now to describe briefly some of the furnaces I have studied in my tour and to finish up with a few details of the producer gas plants employed for supplying the furnaces.

Fig. 1 is an outline of the Dowson unit which is a popular unit in Britain. Indeed, the design follows the standard adopted in that country. The furnace hearth is carried on girder work and is supported independently of the chequer chambers. The hearth is built on cast-iron plates carried on joists and the brickwork in the way of the gas and air ports is almost totally enclosed with mild steel plate. The breast plates supporting the ports are of mild steel, and the arrangement is such that there is a free passage of air under the brickwork. It will be noted that the port uptakes are vertical to

avoid excessive wear on the brickwork, which quickly takes place if there are redundant angles in the passages. The usual practice in this furnace is to carry a silica brick lining 9-in. thick down to the chequer chambers and also to make the arches of these chambers of silica brick.

One gas port only is fitted and the air for combustion is carried up in two ports leading to a common chamber over the top of the gas port. The slag pockets are directly under the ports and the regenerator chambers, which are sufficiently large to preserve the heat throughout each reversal, are clear of the furnace itself.

In the case of smaller furnaces, up to 30 tons capacity, the removable type of port head is usual. This arrangement permits of the correct shape of the ports and blocks being maintained during the life of the furnace arch.

An open hearth furnace, popular in Europe, especially in France, is the Stein, in which the design allows of the regenerators and the slag pockets being completely independent of the furnace proper, and the chequer work can be inspected and cleaned out without difficulty. The furnace roof, which is of simple arch form, is designed for easy repair, and a space is provided under the furnace bed to permit efficient air cooling. A typical arrangement for an open hearth

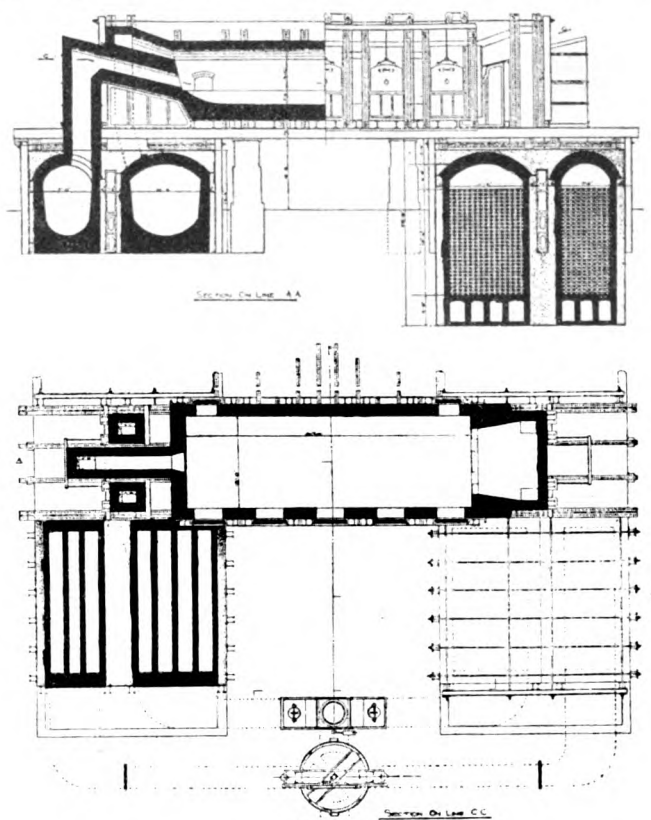


FIG. 1--70-ton producer gas-fired steel melting furnace.

*London, England.

plant equipped with 50-ton Stein furnaces is shown in Fig. 2.

Fig. 3 is a Wincott 50-ton open hearth steel melting furnace designed for the acid process, now in operation in Britain. During a working period of 48 weeks this furnace produced steel on an average coal consumption of 4.82 cwt. per ton. It will be noticed that the furnace chamber and bath are carried independently of the slag pockets, on compound girders and stanchions. Fig. 4 is a chart of operation of this furnace over a period of 44 weeks.

Fig. 5 is the Stein producer gas-fired soaking pit, one of the most extensively used in Europe. These recuperative soaking pits are simply constructed and have the advantage of being easily grouped in batteries, of which each unit constitutes an independent furnace which can be heated, regulated and shut down without affecting the regular operation of the other part of the plant. The furnace slag pit is completely separate, and the gas and air inlets as well as the outlet for the products of combustion are each regulated by a special damper.

In soaking pits of the longitudinally heated type the present practice is to replace furnaces of the lifting lid type, which require special apparatus usually fitted to an overhead traveling crane, by soaking pits with rolling lids, hydraulically or electrically operated. This arrangement allows all the transversal partitions to be eliminated and the cost of the furnace to be reduced in consequence. Fig. 5 is, in fact, a longitudinally-fired soaking pit constructed in France.

Probably more work has been done in developing the design of gas-fired continuous reheating furnaces than of any other type. These furnaces are almost invariably of the recuperator type, and a typical push furnace of the Dowson Mason type is shown in Fig. 6, in which the ingots or billets are laid on a table and pushed into a furnace through a charging door, usually by means of a hydraulic or electric pusher, which also regulates the speed of the material through the furnace. During their passage through the furnace the billets are carried on water-cooled rails or skid bars. In some cases the inclined hearth is carried right to the end of the furnace and the billets are withdrawn at the end. In other cases the inclined hearth ter-

minates at some distance back from the end of the furnace, thus allowing space for the material to be turned over, and the billets can, if necessary, be withdrawn through side doors as shown.

A forging shop erected in a large plant in France is shown in Fig. 7. The operation of these furnaces is very simple and does not entail the employment of skilled labor. The arrangement of the flame inlet passages is such as to prevent the flame impringing on the surface of the material charged. A slightly reducing flame, at a pressure a little above atmospheric, can easily be maintained in the heating chamber.

The saving effected when these gas-fired forge furnaces were installed in the place of the coal-fired furnaces exceeded 50 per cent. This economy is obtained not only by reason of the recuperation of the waste heat, but also from the better operation of the furnaces, by reason of the exact regulation of the mixture of air and gas, and also from the reduction of the radiation losses.

An important application of gas-fired furnaces is in heat treatment, and a large heat treatment shop for armor plate is shown in Fig. 8. The construction of these furnaces depends upon the purpose for which they are required; they are sometimes heated by gas from coal-charged producers, but in certain cases the gas from coke-charged producers is better, for its unvarying composition allows great stability and regularity of temperature to be maintained in the hearth with the minimum of labor.

These furnaces have attached or independent gas producers, according to the importance and the arrangement of the plant of which they constitute a part. They are constructed with a movable bed when the pieces to be heated are of large dimensions, or when

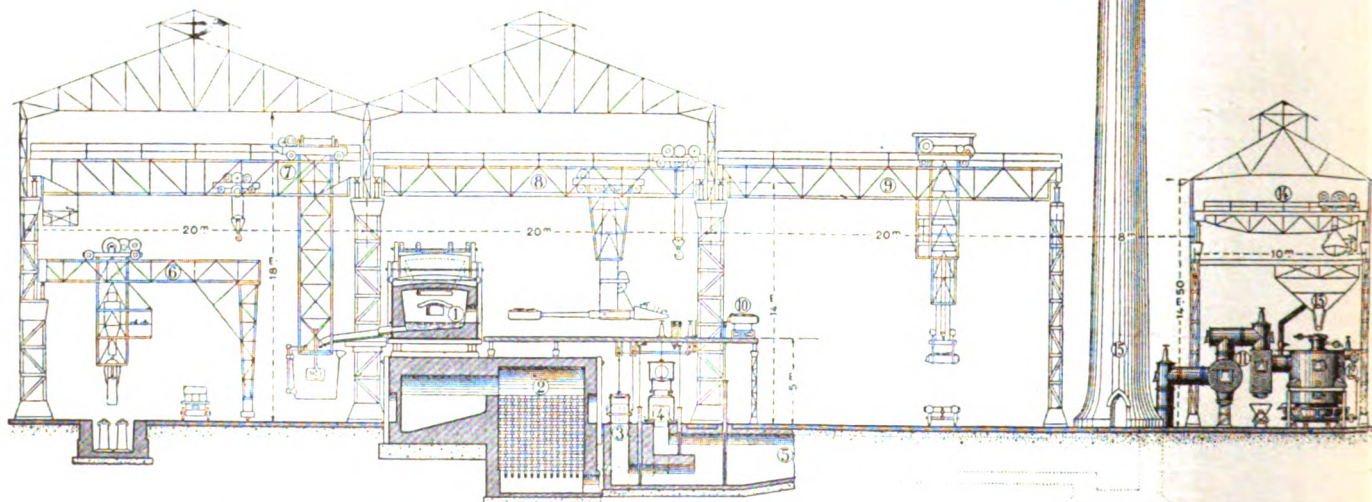


FIG. 2—An open hearth steelworks with 50-ton gas-fired furnaces (in France). Legend: 1, 50-ton furnace; 2, regenerators; 3, air-reversing valve; 4, Forter gas valve; 5, chimney flue; 6, 8-ton overhead traveling stripping crane; 7, 80-ton casting crane; 8, 4-ton charging machine; 9, 10-ton overhead traveling box-lifting crane; 10, stack of charging boxes; 11, gas mains; 12, gas producers with reversing grates; 13, coal hoppers; 14, 4-ton overhead traveling grab bucket crane; 15, stack.

the charging and discharging of the furnace must be carried out very rapidly, so as to enable, for instance, the treatment of a large number of pieces at a time.

Depending upon their length, they are longitudinally or transversely heated, and, in the latter case, in different sections which may be separately regulated.

As a rule they are constructed with continuous recuperation. In certain very special cases, however, they are fitted with regenerators as, for example, in the differential hardening of armor plates. In this process it is necessary to bring one side of the plate to the hardening temperature with sufficient rapidity to prevent the other attaining it, notwithstanding the conductivity of the metal. The regenerative furnace is admirably adapted for this purpose since the great quantity of heat stored up in the chambers can be transformed to the hearth in a very short time.

These, in brief, are some of the outstanding types of producer gas-fired furnaces used in Europe today. Now to turn to the question of the producer gas itself.

Producer gas, when generated, can be supplied to the furnaces as "hot" gas or "cold" gas. When supplied as a hot gas it is not desirable to have the producers located at a greater distance than 450 ft. from the furnaces, owing to the difficulty of maintaining proper gas flow and also to the reduction in temperature of the gas during its passage through the flues. If the temperature of the gas is considerably reduced then the sensible heat is lost, and no advantage is obtained by the installation of "hot" producer gas plant. The best results are obtained when the gas leaves the producer at a temperature of 1100 deg. F., and the connecting flues to the furnaces do not exceed 100 ft. in length.

Cold gas plants are usually installed when it is desired to have one central gas-producing plant installed at a great distance from the furnaces. In this case the gas is cleaned as it leaves the producers and forced along the gas flues or pipes to the furnaces by means of exhausters.

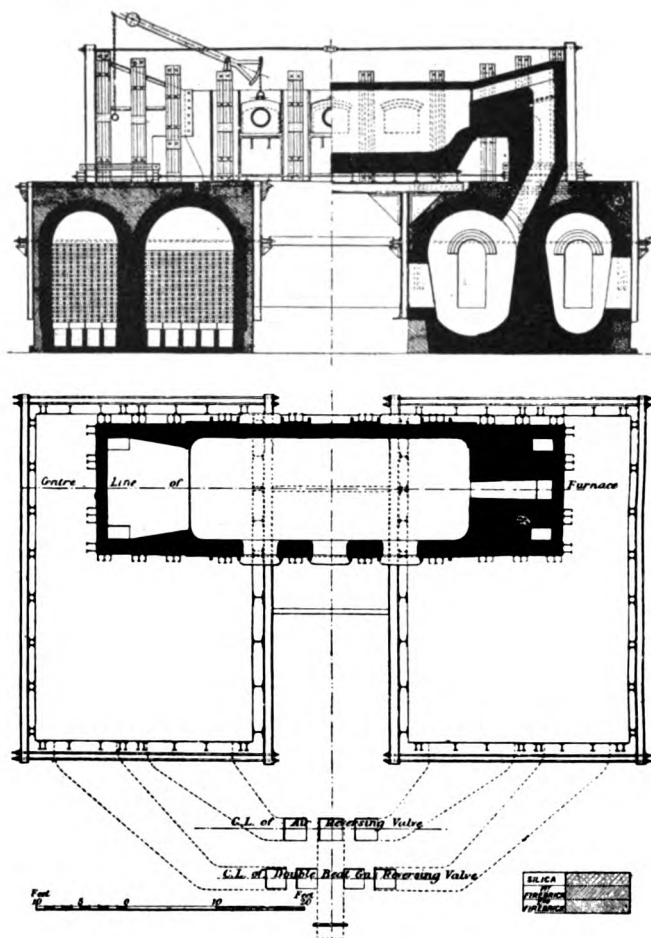


FIG. 3—Installation of a Wincott 50-ton open hearth steel furnace operating on the acid process.

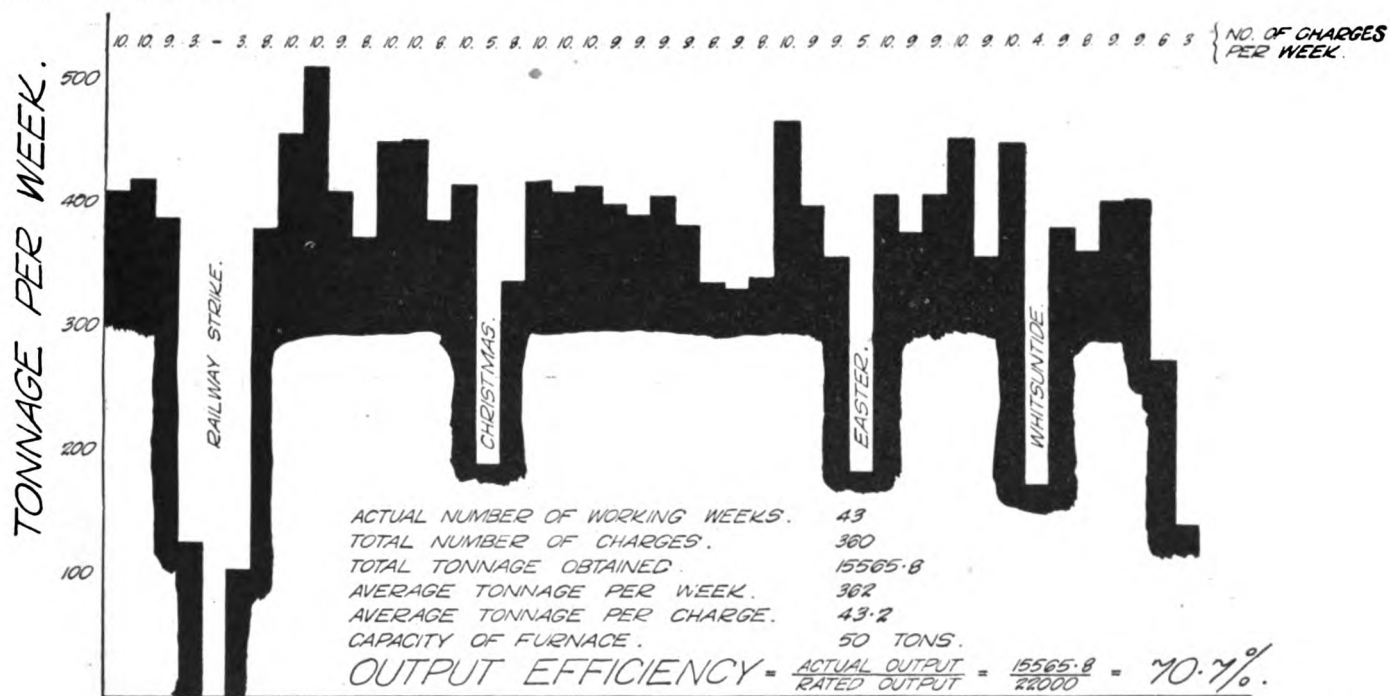


FIG. 4—Graph showing results of 44 weeks' observation on the operation of a 50-ton open hearth steel melting furnace on producer gas.

The choice of the producer to be used is wide and depends very largely upon local conditions. The first question to be decided is whether the producers are to be attached to the furnaces or whether they will be placed apart. This depends upon the quantity of fuel to be gasified in the furnaces, the number of furnaces

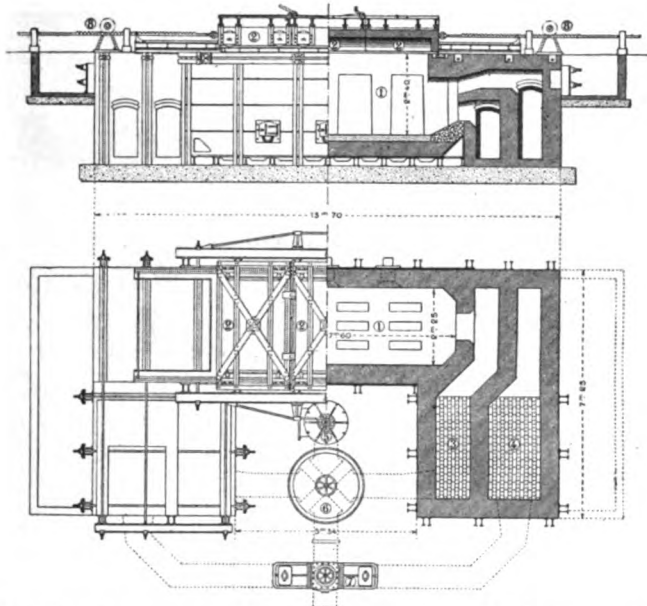


FIG. 5—Arrangement of soaking pits in French plant operated on producer gas. 1, heating chamber; 2, rolling lids; 3, gas regenerator; 4, air regenerator; 5, gas regulating valve; 6, gas-reversing valve; 7, air-reversing valve; 8, rack and gear for moving lids.

to be fired and the manner of handling the fuel. As this decision also affects the first cost of the plant, the question of available capital is important.

Once the position and site of the producers has been decided upon the selection of fuel is the next point. The first cost of the fuel is not the only consideration, but also the operating costs of the various classes of fuel. For example, the case of an annealing furnace requiring a ton of fuel per day. If coal were to be used in the producer the fuel costs would be around 20s. per ton, the operating of the plant, however, necessitates the constant attention of a skilled gas man at the producer, whose daily wage might be 10s. The total cost of fuel and labor would then be 30s. If, in place of coal, coke is used at 24s. per ton, a saving is effected because very little attention is required, and one hours attention per day from an unskilled man would suffice. If he is paid 1s. per hour, then the total cost would be 25s., showing a saving in favor of coke of 5s. a day.

Fuels used for producers in Europe are wood, coke and coal, the two latter being the more common. Coal is generally used for plants of large capacity, and under this class fall Siemens producers, wet bottom producers of the Dawson and Duff types, wet bottom producers with revolving grates for the automatic removal of the ash and for breaking up the clinker, and byproduct recovery producers.

The design of the dry bottom or Siemens producer is determined very largely by the projected installation. Once the specific conditions are known the dimensions of the producer are decided upon, also the shape and profile of the inner lining, the grate area,

the position, size and number of charging hoppers and the poking holes.

A special design of grate and arrangement of charging hoppers allows of coking coals being used without the regular production of gas being interfered with. These producers can be operated with natural or forced draft.

The dry bottom producer, using coal as fuel, requires skilled attention. They can, however, be built conveniently as part of the furnaces they supply, and for this reason their adoption is justified in small installations and in cases where coke is not suitable or cheaply obtained.

The wet bottoms or continuous producers have cylindrical plate casings lined with firebricks, a fire-brick dome being formed over the top of the producer. The body of the producer is supported over a circular water trough by cast-iron columns. Into this trough depends a circular dipper casting which forms a hydraulic seal. The gas escapes through an opening under the producer dome some distance above the level of the fuel so as to avoid its being choked up by the coal. The air blast, containing a certain proportion of steam, is introduced at the bottom of the producer

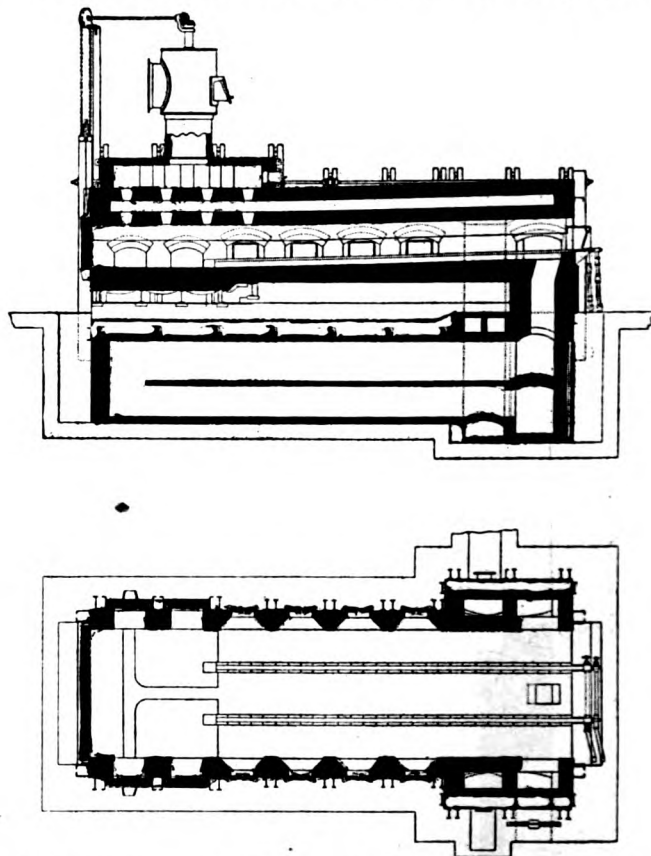


FIG. 6—Continuous billet reheating furnace operated on producer gas.

and passes through a central tuyere fitted with double inverted cones. Top poking holes are located in the dome.

By reason of the cylindrical shape of the producer body and inner lining there is little tendency for the clinker to adhere to the side walls as in the case of producers having conical bottoms.

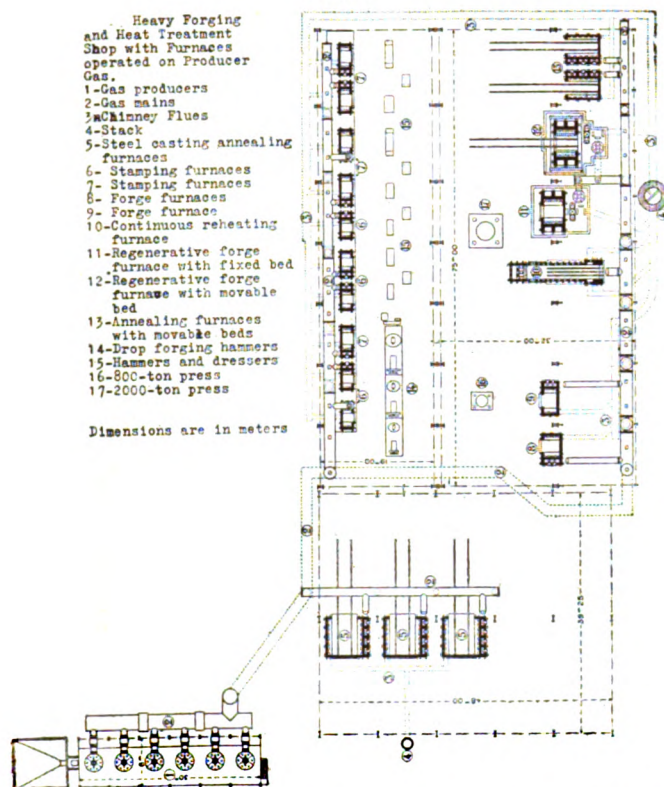
The gas produced is of constant composition with a high calorific power, containing as a rule 26 per cent

carbon monoxide, 10 per cent hydrogen and 3.5 per cent carbon dioxide, though the exact analysis very naturally depends on the type of coal used. These producers will gasify satisfactorily nearly all classes of coal, and there is generally not more than 1 per cent carbon remaining in the ash. The steam injected in the blast is totally decomposed, and the efficiency of these producers often reaches 82 per cent.

The revolving grate producer, shown in Fig. 9, is similar in construction to the wet bottom type, except that the water trough rests on a circular track and is revolved by means of worm gearing, the trough carry-

ing the axis of the grate is not the same as that of the trough or producer body, so that an eccentric movement is given to the grate which assists in the stirring up of the clinker. The shape, slope and number of blades attached to the grate, and of those fitted to the lower portion of the producer body are arranged to

FIG. 7



ing the grate so that the two revolve together. Blades are formed on the grate as well as on the lower inner portion of the producer body, these blades breaking up the clinker and facilitating its fall into the water trough. For the same object and also to stir the fuel,

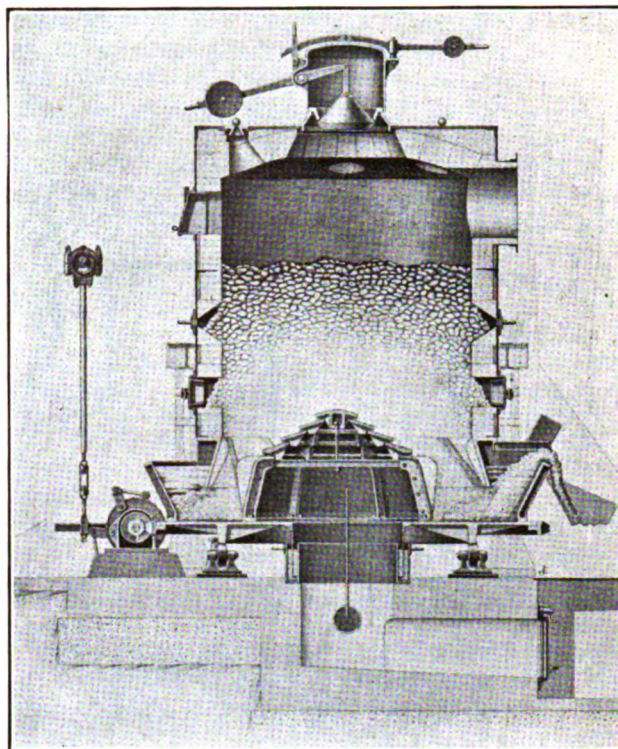


FIG. 9—Mechanical producer with revolving grate.

suit the quality of fuel used. In certain cases the grate only is fitted with crushing blades. The producer grate is connected to the air supply pipe by means of a water seal.

This producer has all the advantages of the ordinary wet bottom type as well as those secured by the additions described above. Low grade fuels can be burnt, and the percentage of unburnt carbon in the ash is often as low as 1 or $\frac{1}{2}$ per cent.

The success of the Duff producer, shown in Fig. 10, is probably due more to the shape of the grate

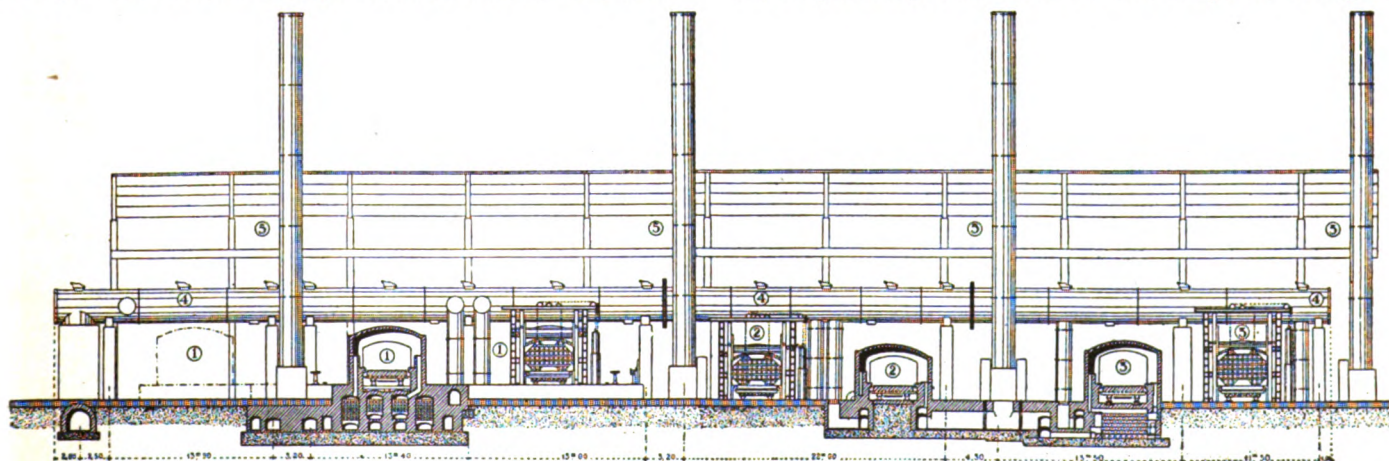


FIG. 8—Heat treatment shop for armor plate with producer gas-fired furnaces. 1, regenerative furnace for heat treatment; 2, heat treatment furnace without regenerators or recuperators; 3, heat treatment furnaces with recuperators; 4, gas main; 5, chimneys. Dimension are in meters.

than to anything else. This grate not only ensures an even distribution of the blast over the entire producer area, but also facilitates the easy descent of the fuel and ash. In a properly designed producer of the static type ashing only requires to be done every 8 or 12 hours, and is a comparatively simple operation.

The Duff producer is rectangular with rounded corners; the grate is of the dog kennel type and the

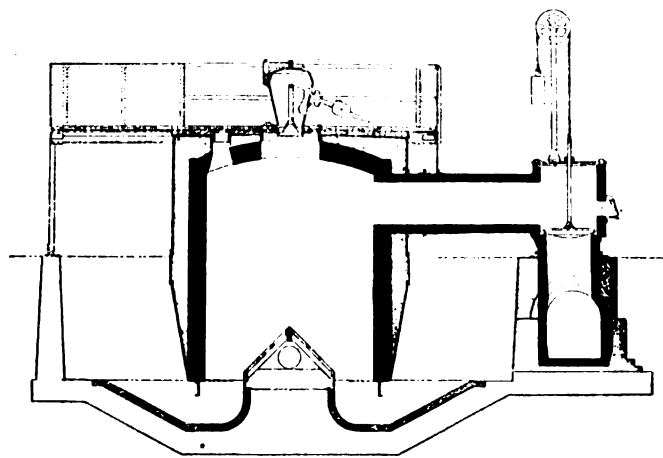


FIG. 10—Duff gas producer.

sloping sides are perforated with narrow slits which distribute the air and steam, yet are too narrow to allow the ash to pass through. The grate extends right across the producer and the sloping sides allow the ash to descend easily into the water lute from which it is removed.

The Duff grate is also constructed in a circular form in which it is possible to arrange so that the blast which passes into the producer through the top cone of the grate shall contain a larger proportion of steam than the blast which passes through the grids. Such an arrangement is advisable when dealing with badly coking fuels, particularly when ammonia recovery is required.

The air for combustion in the smaller plants is usually supplied by means of a steam jet blower, and

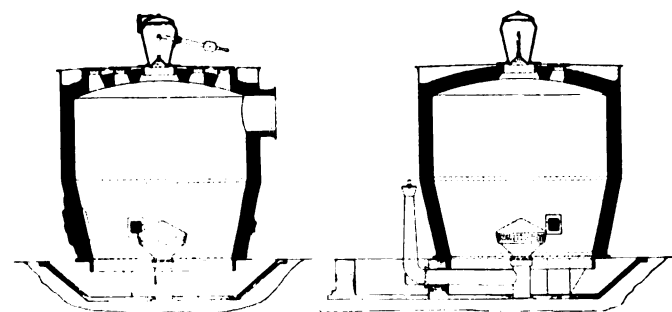


FIG. 11—Water seal central blast fixed type gas producer; 10-ft. 6-in. internal diameter, to gasify 1,300 lbs. of coal per hour.

in the larger plants by fans, steam being added to the blast pipe between the fans and the producers. The quantity of steam added to the blast plays an important part in the proper operation of the producer, and it is necessary to take note of the function which this steam performs, particularly in the case of the by-product recovery producers.

The Wincott producer, Fig. 11, is exceedingly simple in design and operation. It consists of a cylindrical steel shell carried on a massive hematite iron

ring, supporter on piers built in the water seal trough. The necessary steam jet blast pipe, central blast cone and distributing grid are fitted, together with the charging hopper and bell, the inspection door and the top and side poking holes. Firebricks and blocks are used for the lining.

When using a good quality coal these producers have gasified at the rate of 15-lb. per square foot of gas-making area per hour, and these producers are constructed to gasify up to 1,300 lbs. of coal per hour.

Considerable progress is also being made with the gas from by-product coke ovens and blast furnaces for steel furnace heating. The gas from a by-product coke oven has an average gross calorific value of 550 Btu. per cubic ft. and closely approximates manufactured gas in composition, consisting chiefly of hydrogen and methane, and also other hydrocarbons, such as ethylene. Owing to the high hydrogen content this gas has a low specific gravity and care must be observed in the manner of feeding it to the furnaces, otherwise it will hug and tend to burn out the roofs.

CANADIAN CONDITIONS

The announcement that the big plants of the British Empire Steel Corporation at Sydney, N. S., would be closed for three months has been countermanded. J. E. McLurg, manager of the company's steel manufacturing operations, had made the announcement of the pending shutdown, which he attributed to lack of orders. However, at the eleventh hour, the Canadian National Railways sent in an order for rails and other equipment that will keep the plants busy for at least a month. In the meanwhile efforts will be made to induce the Canadian Pacific Railway to send in a large order. The British Empire Steel Corporation closed the machine shops of the plant at New Glasgow last week and the shops will remain closed indefinitely.

The Canadian National Railways are continuing the retrenchment policy in the shops. About one hundred men were laid off last week in the Monoton machine shops. Activities in the Monoton shops were never at such a limited scale as at the present, there being an unprecedented dullness on the road.

The machine shops of the St. John Dry Dock and Shipbuilding Company at East St. John, N. B., which plant was opened last November, have been idle for a month, owing to dearth of business. Some ship repair work and some more important dry dock repairs on steamers are expected before the first of August.

The plant of the defunct firm of James Fleming & Sons, St. John, N. B., was offered at auction and bid in at \$30,000. This is one of the oldest machine shops in America. The firm was established 100 years ago by the late James Fleming. For some years the business has been maintained by his sons. Creditors forced the sale of the assets, a banking firm being the heaviest creditor. The price realized was much lower than anticipated. However, it is said that the property and equipment have been taken over by one of the sons through an agent.

The machine shop of the Nashwaak Pulp & Paper Company of New York City and located at the company's plant in Fairville, N. B., has been closed for several weeks because of the depression. Overhauling of the equipment has been engaged. A new fire-fighting system has been installed in the entire plant, all of the equipment being imported from the U. S.

THE SAFETY CRUSADE

Improved Safety Record Emphasized

Having lost less time from accidents than any other Portland cement plant in the country, the San Antonio Portland Cement Company has been awarded the Portland Cement Association's safety contest trophy. Ninety-nine cement plants participated in the safety contest which determined the winner. The Association will make this contest an annual event, carrying out its policy of co-operating with cement mills to reduce accidents.

The trophy, to be made of cement manufactured at the plant of the winning company, is to be a concrete medallion bearing figures depicting the theme, "Safety Follows Wisdom." Miss Ruth Sherwood, of the Art Institute, Chicago, is the sculptress who designed and modeled the plaque.

The contest itself has been an important contributory factor in reducing the number of accidents in cement plants, according to H. G. Jacobsen, director of the accident prevention bureau of the Portland Cement Association. The cement industry's severity rate in 1923 was 5.411 days lost per 100,000 hours

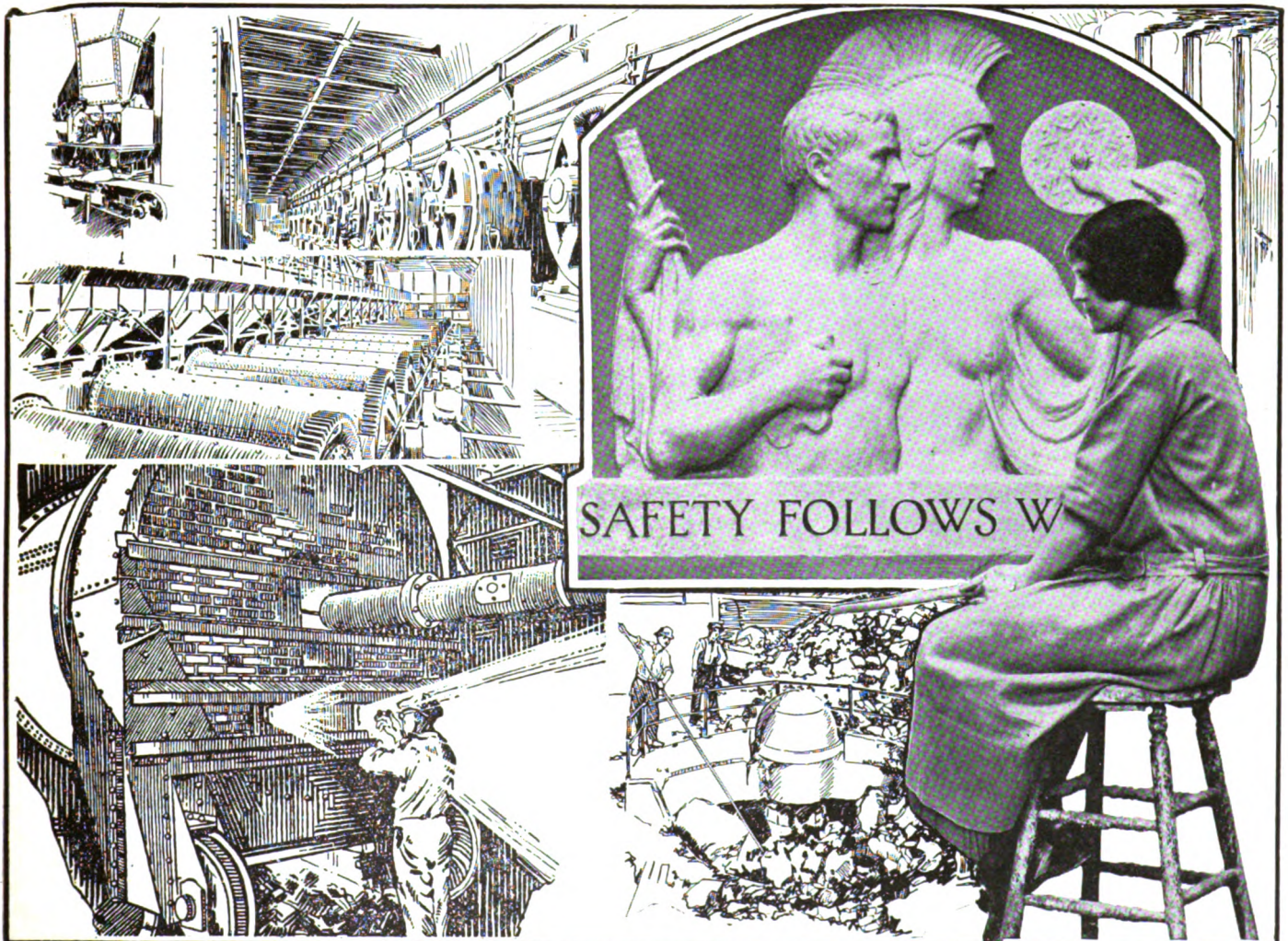
worked, compared with a rate of 6.504 for 1922. This is a marked reduction, whereas other basic industries showed an increase in the severity rate for this period. Fatal accidents were decreased by 30 per cent.

The San Antonio plant, Mr. Jacobsen reports, had only three accidents, which were of a minor character. The plant's record shows that on the average maintained only one day per man in 11½ years would be lost on account of accidents. Several other plants gave the Texas mill a close race. Fourteen plants had better safety records in 1923 than did the plant having the best record in 1919.

"No Accident Month" campaigns have been important factors in lowering the severity rate. In these campaigns the different departments of a plant are in competition. By interesting the men in safety work in this manner great improvement has been shown. The serious consequences of carelessness have been pointed out.

In addition to the hazard of running machinery, such as is found in other industries, cement manufac-

(Concluded on page 417)



CURRENT REVIEW

A. I. & S. E. E. ANNUAL CONVENTION

By R. S. SHOEMAKER*

THE Nineteenth Annual Convention and Exposition of the A. I. & S. E. E. very appropriately will be held this year in the Duquesne Gardens in the City of Pittsburgh; very appropriately, so we think, because as an engineering society devoted solely to the interests of the steel industry, Pittsburgh, the world's greatest steel center, is also our home town and we feel that no better place could be found in which to demonstrate to the industry at large and our own employers in particular the splendid progress made by this Association during the past 18 years.

We feel that this year's work has been very beneficial to our industry and to our membership in many ways, notable among which should be mentioned the very successful fuel-saving conference held in Pittsburgh April second and third by our Combustion Engineering Section, which was attended by the leading Combustion Engineers of the steel and allied industries of the country, at which time many vital problems relating to the more efficient utilization of our fuel supplies were discussed.

January of this year witnessed the publication of our monthly magazine, *The Iron & Steel Engineer*, which has in this short time gained a most enviable position in the trade magazine field and is fast being recognized as the authority on all subjects pertaining to the practical application and utilization of fuel, electricity, machinery and methods as applied to the modern steel plant.

Our branch sections, of which we have five, located at Philadelphia, Birmingham, Cleveland, Chicago and Pittsburgh, have this year been most progressively active in having presented before them papers by the leading engineers of the country covering the most modern and vital subjects, which have been of intense interest and benefit to our managements as well as to our membership.

Standardization of electrical and mechanical equipment of our plants has always been considered of very great importance and we have had for many years committees working to this end on various classes of steel mill apparatus with considerable success, but there yet remains a vast amount of work to be done in this field. We now have our standard specifications for heavy duty cranes, general specification for a.c. main roll drives, mill type motors, etc., but we have always felt that our committees have not been able to freely devote sufficient time to this work and that our companies have not been sufficiently informed as to the mutual benefits to be derived by the steel companies, the manufacturers and the association membership. As a result of this feeling we have during the year communicated with the managements of practically all of the steel companies, explaining in

detail that our work along this line is in every way constructive and will not hamper or limit the manufacturers in developing their apparatus to the most efficient point possible, and requesting that they appoint one or more members of their organization to work with our standards committee chairmen, we have had splendid response from the steel companies and are now in better shape to go forward with this work with committees which have the full backing and understanding of their employers.

At our national convention, held at Milwaukee in 1912, the National Safety Council was born and the



R. S. SHOEMAKER, President A. I. & S. E. E.

slogan "Safety First" was coined, thus marking the first organized safety movement in our mills as well as all other American industry. While statistics most emphatically indicate a tremendous reduction in the number of industrial accidents during the last 12 years, there is yet a great deal of work to be done, particularly of an educational nature, and it is my earnest hope that this, our nineteenth convention, will once more be responsible for a constructive safety movement which will be in line with our policy of expansion and will afford the safety engineers of our industry a medium through which they may better exchange ideas and have the benefits of a national organization interested only in the problems of iron and steel.

*President A. I. & S. E. E.; Superintendent of Maintenance, American Rolling Mill Company, Middletown, Ohio.

Looking ahead, our future as an engineering association looks particularly bright, we are on a sound financial footing, our membership generally is enthusiastic and increasing in numbers; especially so is this true of our foreign enrollment, which indicates that we are more and more each year becoming the exchange medium for progressive engineering within the steel industry of the entire world.

The space allotted me does not permit of my saying much about our future plans, but I cannot let this opportunity pass without expressing the hope that the rank and file of our association will in the future put forth the same effort and show the same spirit of helpfulness toward their national officers and directors, and loyalty to their association as they have shown during the past year—then I know the welfare of the A. I. & S. E. E. will be assured.

WHAT OF THE FUTURE?

By F. W. CRAMER*

THERE was an editorial in one of the papers some few days ago that drew a striking comparison of the swiftness of developments of the present age with those of past ages. In order to bring the picture within the conception of the average man, it assumed as a base figure the "age of man" as 50 years. Then, by comparison, it was found that all our real electrical developments have come within the last two or three days, and bringing the picture more closely home to the steel industry, our large main roll drives are only a day old.

How rapid this development of our main roll drives has been can be brought forcibly home by going back over our yearly proceedings and discovering that our association, though young in years, is older than the oldest main roll drive. Each volume unfolds a new story, a new idea is brought forward, probably against a lot of adverse criticism by some staunch pioneer who had the courage to stand by his convictions, and another type of mill is electrified and put into operation. Sometimes we think the steel industry has been skeptical, and we might even say backward in adopting these new developments—but in reality, when a comparison is made with the battle the steam engine had to replace the hand power and the water wheel, the time is relatively short. Starting just about 15 years ago, as a novelty, main drive electrification has been developed and accepted, and now surpasses its old rival—steam.

At present, we are going through another cycle—a battle between the types of these motor drives—which makes it appear as if the wheels of progress have made a complete revolution and are back to the starting point for a new turn. Years and years ago, in this age of electricity, the d.c. motor was developed and brought into use, and served faithfully on many types of installations. Then as the applications called for larger and larger motors, its newer and formidable rival, the a.c. wound rotor induction motor, began to get recognition and replace the larger d.c. drives until the reversing blooming mill or plate mill motors were about the only large d.c. drives left. The industry, however, needed a variation in speed for several types of mills that the wound rotor induction motor in itself could not give, and in addition, the question of effi-

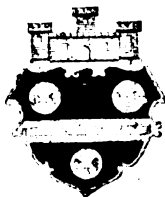
ciencies and low power factors of this type of motor were becoming more and more important, which caused the motor builders to seek and search for new ideas to meet with the demands. The Kraemer system, Scherbius sets, and the Frequency converter systems were all brought forward as solutions to these demands. All three of these are good drives, as the hundreds of installations will bear out, but the complications in control and the multiplicity of apparatus needed for speed variations kept a shadow of doubt hovering over the steel mill electrical man as to whether the best drive had yet been developed. In the midst of all this, first one electrical superintendent and then another began to believe that perhaps an old reliable friend had been spurned too quickly, and that with a little care and development it could be brought back into its old place. As a result of this, we find that the d.c. main roll drive has, within the past year, re-established itself as a formidable rival to the variable speed sets. It had, however, to find an ally in the synchronous motor driven MG set, in order to put itself across, and in combination with this set, the simple control needed, the high efficiency and the wonderful speed variation that could be obtained, rapidly established the d.c. motor as an ideal installation where speed variation in main roll drives was needed.

This ally we have spoken of, the synchronous motor, seems to be like a neglected child, and has had a hard fight to keep a place on the wheel, yet its possibilities are legion. The old criticism "you have too little starting torque" is hard to live down, but it has found some friends that developed a super-synchronous motor, and other friends who brought out the magnetic clutch, and these have eliminated this weakness. Where a constant speed drive is needed, this neglected line of motors is fast finding a place of its own. A simple control, a good power factor, a cheaper motor where direct connection and slow speed are needed are what it offers—all it needs to be put across is some staunch pioneers who will give it a chance.

We have spoken of these rapid changes of main roll drives and their battle to replace steam, and have given the motors the credit—but who made it possible for the motors to get a chance to make good—who has been the super-salesman that put the deal across? The answer to this can be found in the yearly proceedings of the A. I. & S. E. E. No company or individual was big enough—it required the co-operation of a large number of men, and the story of the pioneers who founded this organization, their fight for recognition of the electrical department, the discussions and criticisms at the meetings, and of the new developments year after year, is a story that will go down in history as the reason for the replacing of the steam drives with motors.

And what can we expect of the future? Who is willing to hazard a guess? We know that mill after mill will replace its steam engine with a motor drive. We can expect developments in the types of drive and in new applications, in fact it will only be a few years until the smelting and reducing processes of the steel industry will have reached such a stage of development in existing practice that, in order to further improve operation they will be calling for the more extensive use of the electric furnace to aid in the refinement of the ores, and thus the expansion of the electrical department will continue until it becomes the all important division in the manufacture of steel.

*Assistant Electrical Superintendent, Bethlehem Steel Company, Johnstown, Pa.



CITY OF PITTSBURGH

PENNSYLVANIA

W. A. MAGEE
Mayor

H. E. SPEAKER
Secretary

September 1st, 1924.

Association of Iron and Steel Electrical Engineers,
Pittsburgh, Pa.

Gentlemen:

I take great pleasure in welcoming the delegates of your Convention to our city. The engineers of your Association engaged in the application of electricity in all the many and various phases in which iron and steel are used are filling a very important niche in the development of our city and nation. You gentlemen are the advance guards of progress and as such you are indeed welcome to Pittsburgh.

Iron and steel have brought great wealth to Pittsburgh and made this one of the industrial centers of the world. The almost universal use of iron and steel entering largely into everything that is built, constructed and used, and the application of electricity in thousands of different ways, are two of the outstanding factors of this marvelous age.

Pittsburgh is indeed grateful to and proud of its engineers who have been in a large degree responsible for giving work to thousands of people and for bringing a fair share of the wealth of the world to our doors and homes. Our great iron and steel plants have challenged the admiration of the world, and next to the names of Edison and Marconi no other is so important in the electrical sphere as that of George Westinghouse.

The people of Pittsburgh are in close touch with the thought and genius of men who have wrought so well in iron and steel and who are by electricity astonishing mankind by their marvelous achievements, and this Convention of your organization for the exchange of sentiments, of thoughts, of methods and of ideas on the important subjects in which your organization is interested is one of the promising things of our present day.

The efforts of your organization have been eminently successful and what you have done in the past as an organization is but a prophecy of what you will be able to do in the future. If we could but draw back the curtain of the future, we would not only be astonished but mystified by what is in store for us and for coming generations. We cannot foretell what inventions are in the brain of the future or what garments of glory will be woven on the loom of the coming ages, but we do know that honest endeavor of men who associate themselves together not only for the benefits which they may individually derive, but for the good which they may do for others, is not in vain, and in this kinship of heart and unity of purpose you are real benefactors.

The members of your organization are creators. Every mill, shop, factory and plant began with an idea. By thought that idea developed into a plan, and then through mind-directed effort it materialized into an actuality with physical form and physical characteristics. All the development about Pittsburgh is but the thought of engineers operating in harness of steam and iron and steel. The thinker and the creator must precede the worker. Thus the man who thinks and plans and dreams and creates paves the way for the material things that make us great.

In welcoming you to Pittsburgh, I wish you to remember that our best product is manhood and womanhood. We are justly proud of our material wealth and greatness, but we are not afraid to be judged by the prevailing type of our manhood and womanhood. May your visit here be pleasant and profitable, and when you separate and go your several ways may something gathered here last through life as a remembrance of Pittsburgh.

Cordially yours,

W. A. Magee
M A Y O R.

We also know that there are bound to be great developments in the source of this power—the steam turbine and the hydro-electric plant, and that the dream of a great super-power system will some day be realized. Certain developments, during the past two years, point out that a new type of friendship between the large public service companies and the steel mills is about to be established and the age-old debates “purchased vs. home-made power, or 25 vs. 60 cycles” will be revived to be discussed and settled in a business-like way. But whatever the future may bring, the A. I. & S. E. E. will serve as the melting pot, the guide and counsel where these questions can be thrashed out among friends, and the proceedings will add chapter after chapter in this interesting story in the years to come.

You owe it to your company, and your company owes it to you that a common bond be established between yourself and the association. We are no longer fighting for recognition, but are firmly established. The papers presented at the meetings are recorded as authorities on the subjects; in fact the power of the association is so great that it almost controls the destiny of the steel mill electrical applications. Our convention exhibits have grown so fast that it is difficult to find a building that will house them, and space is now at a premium instead of being an effort to sell, showing the high place we occupy in the minds of the manufacturers.

You will find that the electrical development of the steel industry and the Association of Iron & Steel Electrical Engineers are bound hand and foot, and that the more active part that you take in the association, the greater will be your part in this development, and as the story of this progress is recorded, year after year, your part in the work will be preserved for the coming generations.

DEVELOPMENTS IN THE ACTIVITY OF THE A. I. & S. E. E.

By A. C. CUMMINS*

IN considering the trend of the activities of the Association of Iron & Steel Electrical Engineers, it is not possible to avoid the conclusion that the field of effort of this Association has greatly broadened during the past few years. An examination of subjects recently discussed under its auspices immediately places it under the classification of a general steel mill engineers' society rather than an organization of engineers whose meetings deal exclusively with the discussion of electrical engineering problems.

Further consideration of the cause of this enlargement of activity leads to the conclusion that the Association has had no choice in the matter of determining this policy. The enlarged engineering responsibilities of its membership demanded a broadening of the field of the Association if it wished to continue to give service. So rapidly has the use of electricity in the steel industry progressed that every mill improvement now entails an extensive study of the various applications on which the use of electricity may be advantageously adopted. The steel mill electrical engineer is now required to be thoroughly familiar with general steel mill engineering practices in order that he may ably supervise the application of electric drive, and obtain the maximum advantage

to be gained by such applications. Thus the demand for broader engineering information has been created and in filling this demand the Association has found it necessary to enlarge the scope of its activities or else fail to live up to the well merited tradition of service to its membership.

The present year has witnessed two outstanding developments in what might be termed “servicing the membership.” The first of these has been the change in size and character of the monthly publication. In enlarging the size, the Association has followed the policy of other engineering periodicals and the same mechanical advantages in presenting the subject matter have been secured. There is a marked improvement in the subject matter presented and in the more general nature of its engineering interest. The more liberal dimensions permit the publication of many valuable papers presented at section meetings which hitherto could not be printed on account of lack of space.

In the future it may develop that contributions to the monthly magazine will be accepted which cannot be worked into meeting programs, thus giving the membership additional information on subjects other than those actually discussed in general or section meetings. It is recognized, however, that such practice is open to objection, that great care must be used in selecting papers published without discussion in order to avoid the possibility of impairing the excellent reputation for accuracy now possessed by the “Proceedings.”

The second outstanding development of the past year has been the holding of the First Fuel Saving Conference. Many of our members feel that a steel mill electrical engineer must be fully posted on the advances made in the efficient utilization of fuel. For a number of years it has been the custom to devote a day of the Annual Convention to the discussion of the fuel saving problem. At the close of the last Annual Convention at Buffalo it was decided that the time was not sufficient and that a two or three day special spring meeting devoted to the discussion of fuel savings should be inaugurated. Accordingly the First Fuel Savings Conference was held in Pittsburgh in April, 1924. This conference was unusually well attended and the interest displayed on the part of those present indicated a necessity for such a meeting. Such conferences fill a demand that is not covered by any other engineering society and will be continued.

As to future development in the Association's activities no one can do more than surmise. When it is recalled that the steel mill electrical engineer less than 30 years ago was either caring for a few lights or adjusting brushes on a generator, while now his advice is sought in nearly every steel mill engineering problem, and that this Association has always filled the demand of its membership for development, it can be said with conservation that the future of this Society will reflect the development of the utilization of electricity in the steel industry and the importance of the steel mill electrical engineer. Those who have had the vision and the determination to place the use of electricity in the steel industry in the high position it now possesses as a means of doing work will not cease their activity at the present stage of its development, nor will the research engineers or the designing engineers cease in the improvement of the means offered the steel mill engineer to further

*Electrical Supt., Carnegie Steel Company, Duquesne, Pa.

the use of electricity. Therefore the future development of the Association must be a continually broadening one until it eventually must become an organization for all classes of steel mill engineers at or before the time when the steel industry becomes 100 per cent electrified.

As surely as the use of electricity in the steel industry is on the threshold of still greater development, the steel mill electrical engineer is on the way to greater recognition. It is the duty of the Association to aid him in his quest for further development. How will it do it? It must act as an educational medium for continued engineering information, an advertising agent to place himself before his public and enable him to sell himself, and finally it must urge that in his enthusiasm for the engineering specialty that is his selected profession, he must never be carried beyond the ethical standards of the engineering profession.

THE VALUE OF CONVENTIONS

By A. J. STANDING*

CONVENTIONS, as the name implies, are gatherings of people who are called together to accomplish, by means of unity of purpose, certain constructive results that could not otherwise be achieved. After all, conventions are made up of individuals and, therefore, the success of any convention, both from the standpoint of its accomplishments as a convention as well as the standpoint of individual gain, must be measured in the final analysis in terms of individual effort. In other words, a convention is what



A. J. STANDING, Chairman,
Banquet Committee A. I. & S. E. E.

the individuals make it, and each attending member gains only in proportion to the effort he exerts to derive benefit from the convention.

The most obvious service any individual can render in behalf of our convention is to attend the various technical sessions and show interest in the industrial exhibits; by so doing he gives the support of his presence to those who strive to make all the features a success.

The conventions of our A. I. & S. E. E. have a four-

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fold value to those accredited representatives of steel plant electrical departments who attend with the object of getting the greatest possible return for the companies they represent on the money invested in sending them to these conventions.

First, and logically so, is the direct benefit gained by hearing the technical papers read and taking part in the discussion of such papers and reports as are directly of interest to us.

Second is the benefit to be gained from close inspection and discussion of the many interesting and profitable exhibits and actual demonstrations that have become such a prominent part of our conventions. Information gained by actual observation is so much more readily retained.

Third, I feel that the association with men in similar lines of activity, the questions and answers brought up in the many private discussions, are all a very vital part of the actual assimilated knowledge one can take away from our conventions.

Fourth, I place the value of acquaintanceship and sociability fostered among officers, members and associates as being of inestimable value in broadening a man's outlook and his knowledge of the personnel of the electrical end of the steel industry as a whole. Through the friendships begun at our convention there grows a feeling of fraternity that can be counted on in almost any situation that may arise in the actual operation of our various departments and is being more and more used as a medium of exchange of ideas helpful to each other.

I know of no other Association whose conventions are fruitful of more that is of actual lasting value to its members than are our own, provided, of course, we each do our share toward making each feature a success.

There is one other point to be borne in mind, and that is the realization we should all have that when we are assembled in convention we are always the responsible representatives of various steel plants, and the conduct of our entire convention is judged by industry at large in that light. It behooves us all, therefore, to keep the name and fame of the convention of the Association of Iron and Steel Electrical Engineers above reproach.

WHY ELECTRIFICATION OF MILL DRIVES IS ECONOMICAL

By S. S. WALES*

THE uses of the electric motor today covers a much wider range than its most partisan advocates hoped for when it first entered the mechanical world as a substitute for the earlier devices for distributing power.

The wizard of the electrical fraternity, Thomas A. Edison, at the time he introduced the incandescent lamp, proposed running the entire surface car system of New York City, as it then existed, by electric motor, but advanced as that thought was, it has been surpassed in reality by the wonderful development of the electric locomotive, which is capable of doing the work of three powerful steam engines on the heavy grades in the Rocky Mountains.

*Electrical Engineer, Carnegie Steel Company, Pittsburgh, Pa.

Thomas McDonald, formerly general manager of one of the large steel plants of the country, in 1896 while building a mill in which all auxiliaries were electrically driven, suggested motor driven main rolls for non-reversing mills, but even his dream has been surpassed by the modern reversing booming mill and continuous mill with their controlling, limiting and protective devices which almost appear to think for themselves.

While a few men of vision and imagination were looking forward and predicting a wonderful future for this new tool that electricity had put into their hands, it is fair to ask what basic reason gave its present supremacy to the electric motor and why it so



S. S. WALES, Director A. I. & S. E. E.

successfully supersedes other power producing units even for main roll drives, and it is interesting to find that this basis is not really electrical.

Sentiment has had little to do with the rapid advance of electric power production, distribution and use in the mill, and to some extent the art has developed backwards, that is from the motor through the distribution system, back to production equipment in reverse order to its discovery. While now resting on the firm foundation of saving in cost over other methods and carrying the two advantages of safety and convenience, it was very fortunate for the infant science that there were steam and hydraulic applications in the mills, where efficiency need not be considered, and to which electric power was admirably adapted even in its crude form.

Steel mill electric power development began about 1892 with the motorizing of pass and runout tables on some old type hand served mills, and by the introduction of electric overhead traveling cranes for roll changing. The electric cranes, charging machines and pass tables immediately took their places in the

mill and, with few very minor exceptions, superseded all other methods of lifting and transferring material, purely on the ground of ease of transmission of power from a fixed to a moving point. Here efficiency did not enter the question very largely, as compared with convenience.

The fixed motors, running roller tables, etc., had only efficiency to stand on, but the steam consumed by the small hoisting engines then used and the condensation losses in the long small steam lines, gave ample margin for the motor to show an advantage.

At that time power was generated by units of which the 200-hp., belted, 250-volt, d.c. generator was a fair average, the prime movers being single cylinder, simple, non-condensing, side valve engines, using steam at about 100-lb. gauge pressure. The over-all efficiency of these units could not have exceeded $2\frac{1}{2}$ per cent or 400 lbs. of steam per kwh. After the power had been produced with this tremendous waste, it was transmitted for a distance of from 500 to 1,000 ft. with line losses based on 10 per cent to 20 per cent drop at normal load, peaks not considered, and 60-deg. copper temperature to motors probably averaging 75 per cent efficiency, and strange as it may seem, the first radical improvements in the whole system appeared in the motors. In rapid succession the open type double reduction motor was followed by the open type single reduction, the semi-enclosed single reduction, the wholly enclosed and then the special mill type motor, which was the first concession made by the electrical manufacturers and designers to the steel industry.

During the motor development, transmission lines had been extending until the size of copper and first cost had become a considerable item, so the next improvement followed back from the motor to the line. Slow speed steam engines with large alternating generators were installed, with slightly improved efficiency over the early d.c. equipments, and power was carried at 6600 volts a.c. to the center of consumption, where it was transformed to 250-volt d.c. for use by means of static transformers and rotary converters, which is substantially the method employed today, except that the high speed motor generator set, taking 6600 volts at the a.c. end, has largely superseded the rotary converter due to flexibility and its ability to correct low power factor.

For a long time the competition between the electric motor and other forms of power users was confined to small units and to places inaccessible to steam engines so that it was only when a daring attack was made on an actual electrical mill drive, using d.c. generation, transmission and main roll motor, that the steam drive developed its real strength, which lay in the fact that the central station generating units could not be of appreciably larger size or higher efficiency than the engine that would be required to run the mill direct.

In estimating the economies of such equipment, the engineer was confronted with additional losses, instead of savings, which no amount of "convenience" or "safety" could overrule, and it was only when the electrical industry produced the steam turbine generator that the complete electrification of the rolling mill became an economic possibility. So the final step in the backward line of progress was taken, and the reciprocating steam engine was in full retreat before the victorious motor, except for a rear guard action

set up by the uniflow engine, which did not develop the strength its friends expected.

It appears, then, that the basic foundation of the success of the electric motor in replacing steam engines in power development in steel mills is not due to the increase in the power, reliability and efficiency of the motor itself, or in its transmission system, but principally to a radical improvement in the method of using steam itself by means of the turbine, which is more perfectly adapted in speed and construction to driving electric generators than to direct connection to the machinery of the mill.

In some favored sections, where large water powers are available, this will not hold good, but where fuel is the source of power then the turbo-generator must stand as the strongest ally of electric power users. So, with all his pride in the wonderful progress in electrification, the electrical engineer must bow to the steam engineer, who has defeated himself.

Under average conditions and with up-to-date transmission lines and motors, one hp. engine can be delivered to the roll necks of a non-reversing mill by the electric route, using modern compound condensing engines for 2.47 lbs. of coal at the boilers, as against 2.19 lbs. of coal with the same engine direct connected to the mill, including line losses, or an increase of coal consumption of about 13 per cent, whereas with the same electric route, using steam turbine generated power, 1 hp. can be delivered to the rolls for 1.53 lbs. of coal, or a decrease in coal consumption of about 30 per cent over the direct connected roll engine, due entirely to the advantage of the turbo-generator over the engine-driven generator.

COMBUSTION AND FUEL ECONOMY

By W. P. CHANDLER*

THE fuel bill of the steel industry is the greatest raw material cost which has to be met. During the last decade the bill has been climbing by leaps and bounds and it is little wonder that combustion, the process consuming this raw material, has been receiving particular attention. In the field of electric power generation the demand for economical use of fuel is even more pronounced, since it is the largest single item of expense, and it is in this field that we see the greatest economies being obtained.

In existing plants the economies are usually brought about by the installation of accessory equipment, such as draft regulation, which will produce more nearly perfect combustion, or by making certain changes in stoker or burner design so that a more intimate mixture of fuel and air will take place. Very great economies can also be obtained by improvements in the generation, transportation and utilization of the steam, the intermediate medium between the fuel and the electric power, and while not strictly in the combustion field it usually falls under the same supervision.

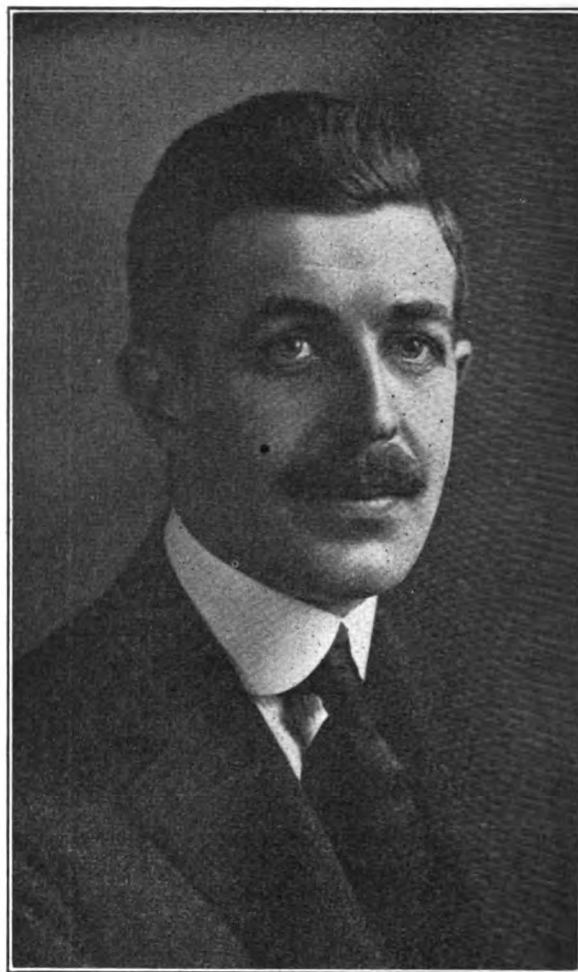
The really large economies, however, are obtained by replacing old equipment with that of recent improved design. This normally requires the expenditure of large sums of money and naturally is much slower of accomplishment.

*Fuel and Experimental Engineer, Carnegie Steel Company, Duquesne, Pa.

The boiler of 20 years ago might give 60 per cent efficiency if the firemen were both careful and skillful, but usually the practice was considerably under this figure.

As a comparison, tests conducted at central stations of recent design have shown efficiencies well over 90 per cent for the combined steam-generating equipment.

This improvement in the utilization of fuel in the power houses of the country has been reflected in the government's reports, which show that in the last four



W. P. CHANDLER, Secretary,
Combustion Engineering Section A. I. & S. E. E.

years the number of kwh. produced per ton of coal has jumped from 625 to 835, a gain of 33 1/3 per cent.

The supervision of combustion in a steel mill, however, extends far beyond the boilers of the power-generating system. Each department of the plant requires furnaces designed especially for its needs. The fuel best suited to the purpose, or most advantageously obtained, must be supplied in the proper amount and so as to produce the proper working temperature for the process. The heat in the products of combustion leaving the main body of the furnace must be reclaimed as completely as possible, in order to insure the lowest possible fuel consumption.

The blast furnace departments at the present time are probably leading in the matter of fuel economy. The gases leaving the top of the furnace are consumed under boilers or in hot blast stoves or internal combustion engines. The economies obtained in recent

LIST OF EXHIBITORS IRON AND STEEL EXPOSITION

September 15-20, Pittsburgh, Pa.

Name	Booth	Name	Booth
Alfred Box & Company.....	2	Moloney Electric Company.....	154
Allen Bradley Company.....	116	Monitor Controller Company.....	7
Alliance Machine Company.....	82	Morgan Engineering Company.....	66, 67
Allis Chalmers Manufacturing Company....	68	Mutual Electric & Machine Company.....	19
Appleton Electric Company.....	111, 118	Mutual Foundry & Machine Company.....	5, 6
Automatic Reclosing Circuit Breaker Co....	21	W. A. McCombs Company.....	4
American Engineering Company.....	159	McGraw-Hill Company	11
Baker R & L Company.....	93, 94, 95	C. H. McCullough Engineering Company....	25
Bartlett Hayward Company.....	84, 85	National Carbon Company.....	89
Benjamin Electric Manufacturing Company..	79	National Electric Manufacturing Company ..	77
W. A. Bittner Company.....	56	New Departure Manufacturing Company... 137, 138	
Bussmann Manufacturing Company.....	115	Nichols-Lintern Company.....	10
Bacharach Industrial Instrument Co.....	39	Norma Company of America.....	158
Central Electric Company.....	87	Ohio Electric & Controller Company.....	18
Chicago Fuse & Manufacturing Company....	22	Okonite Wire & Cable Company.....	3
Chicago Pneumatic Tool Company.....	15, 16	Otis Elevator Company.....	29, 30, 31
Corliss Carbon Company.....	40	Packard Electric Company.....	60, 61
Crocker Wheeler Company.....	59	Pawling-Harnischfeger Company	156
Crouse Hinds Company.....	90, 99	Pittsburgh Electric Furnace Corporation... 70, 71	
Cutler Hammer Manufacturing Co.....	74, 75	Pittsburgh Transformer Company.....	23, 24
The Cutter Company.....	13	Pyle National Company.....	41
The Calorizing Company.....	47	Pittsburgh Electrical & Machine Works.....	64
Delta Star Electric Company.....	155	Payne-Dean, Ltd.	76
Detrick Arch Company.....	53	Reed Air Filter Company.....	131
Doubleday Hill Electric Company.....	72	Railway & Industrial Engineering Company	98
Dravo Doyle Company.....	150	Republic Flow Meter Company.....	54
Duquesne Light Company.....	36, 37, 38	H. Lee Reynolds Company.....	91, 92
Eastman Graf Company.....	1	Robinson Ventilating Company.....	Lobby
Economy Fuse & Manufacturing Company..	35	Rollway Bearing Company.....	17
Edison Storage Battery Company.....	83	Rutherford & Uptegraff.....	62, 63
Electric Controller & Manufacturing Co....	80, 81	Reliance Electric & Engineering Co., 140, 141, 148, 149	
The Electric Journal.....	134	Rowan Controller Company.....	157
Electric Materials Company.....	78	The Sharples Specialty Company.....	136
Electric Service Supplies Company.....	50, 51	Square D Company.....	20
Electric Storage Battery Company.....	46	SKF Industries, Inc.....	144
Electrical World	11	Standard Underground Cable Company.....	73
Fairbanks Morse Company.....	112, 117	Stroh Steel Hardening Process Company....	55
Fuels and Furnaces.....	12	The Superheater Company.....	114
Fuller Lehigh Company.....	32, 33	Shepard Electric Crane & Hoist Company... 42, 43	
Farrell Foundry & Machine Company.....	96, 97	Wm. Swindell & Company.....	151
General Electric Company.....	120 to 129	Thermoid Rubber Company.....	152
The Hayward Company.....	135, 136	Thomas Flexible Coupling Company.....	132
Herr & Harris Company.....	12	Tool Steel Gear & Pinion Company.....	14
Ludwig Hommel & Company.....	110, 119	Trumbull Electric Manufacturing Company..	52
Hyatt Roller Bearing Company.....	69	Thompson Electric Company.....	88
Homestead Valve Manufacturing Company..	44	Union Electric Company.....	34
Iron City Electric Company.....	45	U. S. Graphite Company.....	26
Jos. Jacques	145	V. V. Fittings Company.....	130, 139
Johns Manville Company, Inc.....	65	Vulcan Soot Cleaner Company.....	133
W. A. Jones Foundry & Machine Co.....	113	Western Electric Company.....	48, 49
Keystone Lubricating Company.....	57, 58	Westinghouse Electric & Manufacturing	
H. Kleinhans Company.....	142, 143, 146, 147	Company	100 to 109
Lakewood Engineering Company.....	28	Westinghouse Lamp Company.....	86
J. Frank Lanning Company.....	153	West Penn Power Company.....	36, 37, 38
Laughlin & Barney.....	160, 161		

boiler installations show exceptionally low losses of heat and hot blast stoves of 75 to 80 per cent efficiency are being installed. However, the greatest fuel economies have been made possible by the use of internal combustion engines.

The other departments in the steel mill have also been the subject of considerable study for the combustion engineer and the open hearth and heating furnaces are beginning to show gratifying reductions in their fuel consumptions.

Here a woeful waste in fuel had been in practice for years, and the fuel savings possible were therefore all the greater.

The open hearth furnace, with its very high operating furnace temperature, resolves itself into a problem of waste heat reclamation. The answer has been regenerators, recuperators or waste heat boilers in which the heat is returned to the furnace or absorbed by a secondary medium. The problem of the heating furnace is a similar one, except to a lesser degree, since continuous furnaces have made possible a much greater absorption of heat in the main chamber and reduced the reclamation problem correspondingly. Great developments along these lines have already taken place and much improvement in fuel economies should be expected in these departments during the next few years.

The field of fuel conservation, combustion engineering or whatever it may be termed is a very broad one. When a new furnace is to be built the first step is the selection of the fuel which is to be used. The decision rests on availability and price. Once the fuel is determined its storage, preparation and introduction into the furnace must be considered. Means must be provided for supplying the air necessary for combustion. If high temperatures are required the necessary preheat for the air, the fuel or both, must be obtained. The design of the furnace must be such that a maximum of the heat generated in the combustion chamber will be absorbed by the metal being processed. The hot waste gases leaving the furnace proper must pass through some heat reclaiming device in order to prevent an other wise large stack loss.

Each step must be considered separately and then the whole tied together before the design of the finished equipment can be completed.

The combustion engineer has a big field to cover in efforts toward lower fuel bills, and with the ever-increasing cost of the various fuels the demands for such savings will be more and more insistent.

—Iron and Steel Engineer, Editorial Section.

IRON TRADE REVIEW

July 31.

A moderate recovery is developing in the iron and steel markets and some broadening in the scope of demand is apparent. The pig iron market shows a strengthening tone and furnaces represented with headquarters at Cleveland this week booked over 200,000 tons.

Iron Trade Review's composite of 14 leading iron and steel products this week is \$39.47, compared with \$39.53 in the preceding week and \$47.26 a year ago.

A survey of European business conditions made by Iron Trade Review's resident correspondent in Europe, shows that trade is good in four European nations, namely France, Italy, Sweden and Belgium;

fair in 17 and poor in five. European trade in general is awaiting result of the Dawes plan of action.

August 7.

Mill and steel works operations are showing further moderate gain. July pig iron production indicates a slowing down of the curtailment process. A decrease of 14.6 per cent in output in July as compared with the decline of 20 per cent in June and 21 per cent in May. July production was at the rate of 21,000,000 tons annually as against a rate of 40,800,000 tons in March. The July output of 57,541 tons daily was the lowest since January, 1922, and represented a loss of 48.5 per cent from a high point of the year in March. Total production in July was 1,783,778 tons, compared with 2,022,836 tons in June. Active furnaces at the end of July numbered 146, or 12 less than at the end of June.

An easier situation in the steel market has reduced Iron Trade Review's composite this week to \$39.29, compared with \$39.47 in the week preceding. Lake Superior iron ore prices as much as 50 cents a ton below the open market quotations have been offered. The largest recent sale is 200,000 tons to the American Radiator Company. More than 100 Great Lakes iron ore carriers have been taken off the active list.

A feature of Iron Trade Review's cablegram from London this week is that pig iron made in India is being offered in England in competition with the domestic production. A British firm has obtained an order for 1,500 tons of tram rails for the city of Hull, England, despite a much lower offer from Germany, due to the sentiment prevailing against the low wages paid the German workmen and the longer working hours.

An article in this issue by Robert T. Mason gives facts and figures relating to the 1924 road-building program involving large tonnages of steel.

The increase in the Southern consumption of pig iron that is made in the South is pointed out in an article in this issue. Only eight per cent of Southern pig iron was used in the South in 1911, while last year the proportion was 62.4 per cent, this being a sidelight in industrial development in the South.

A report of the engineer committee investigating super-power development in the Northeastern section of the United States gave considerable detail in this issue, and reveals that the super-power plan may result in an annual saving of 15,000,000 tons of coal.

August 14.

Pig iron prices are stronger in all the leading markets. In the Chicago district they have been marked up 50 cents. Late buyers are beginning to come into the market and there is considerably more activity than during the past month. Foundry iron at less than \$19 has practically disappeared in Northern markets.

Iron Trade Review's composite shows an increase this week for the first time since February 14, 1924. The composite now is \$39.21 as compared with \$39.29. Lower prices of certain finished steel products and especially sheets are more than offset by the firmer position of pig iron.

Iron Trade Review's cablegram this week points out that since the McKenna duties were repelled in Great Britain, August 1, the output of motor parts in Sheffield has been reduced one-third. The steel makers are complaining that the government com-

mittee for investigating the steel industry with particular reference to foreign trade, is dominated by free traders.

The business trend section this week shows that business sentiment continues to improve, numerous economical indications now being promised for the immediate outlook, some of them being a small decline in July steel orders, with other signs of a turn in the steel trade; continued strengthening of grain prices; rapid strides toward an agreement on the Dawes plan; the advance of commodity price indices.

A number of articles in this issue are devoted to the foundry trade, including one by W. J. Corbett, industrial engineer, the Electric Steel Founders Research Club, Chicago, pointing out the fallacy of basing prices of steel castings on their weight. Another by Lieut. Com. A. M. Charlton describes some of the foundry practices on large war ships. Another article relating to prices of castings gives the experience of one company in determining selling prices by two factors, actual time required and amount of metal used. The experience of New Jersey foundrymen in co-operating with the Boys' Vocational School at Newark for the training of apprentices are shown in this issue.

August 21.

Prices of pig iron are up 50 cents in practically all of the leading markets. The Valley price now is \$19.50 and one large merchant furnace interest has increased its quotation to \$20 after booking about 30,000 tons during the week at outstanding lower figures.

Iron Trade Review's composite shows a slight gain again to \$39.75, compared with \$39.31 in the week preceding.

This issue contains a special insert devoted to the iron and steel and general industrial position of St. Louis, giving the results of a survey of St. Louis' position with respect to materials, products, manufactured products and transportation.

An article describes the Shoenberger Works in Pittsburgh that is 100 years old this year.

Spending \$5,000,000 Monthly

Steel Corporation Extension Work as Indicative of Confidence in Business Outlook

The United States Steel Corporation is making larger expenditures for extensions and improvements than were supposed a few months ago would be necessary or possible, according to Judge Elbert H. Gary, chairman of the corporation, who was interviewed by newspaper men on Tuesday afternoon, August 26. "We are expending at the present time," said he, "at the rate of about \$5,000,000 per month for extensions and improvements, and our present intentions are to continue to expend at least that amount for the remainder of the year. This appears to us to be necessary to take care of the business on hand and the business we expect to receive."

The statement was made in the course of a general discussion on the status of business. "As I have told you before," he continued, "there has been a steady, perceptible, though small, improvement in our business, commencing several months ago. The improvement has up to date been greater than I expected it

would be and is fully as much as I would like to see it. I mean by that I would rather see a slow, steady and persistent growth in business than to see a rapid progress that might result in a sudden material reaction at any time.

"Our new business, that is, our bookings of new orders, according to the last report received, for the first 22 days in August were 10 per cent more than they were during the same time in July, and July, as you know, was somewhat larger than June, and so on. Our shipments for the first 16 days of August were 18.3 per cent larger than they were for the first 16 days of July. It seems to me that showing should be considered very satisfactory.—Iron Age, Aug. 28.

OBITUARY

Jacob H. Mohr, superintendent of Carrie furnaces of the Carnegie Steel Company, Rankin, Pa., was killed in an automobile accident at the plant, August 4. In company with M. J. Ryan, Mr. Mohr was leaving the plant in an automobile driven by Mr. Ryan. It is said that, misunderstanding the signal of the watchman, Mr. Ryan drove across the railroad track on which a plant switching engine was backing. In attempting to leave the car, Mr. Mohr was pinched between the railroad car and the automobile, receiving internal injuries from which he died on the way to the hospital. Except for a period of about a year and one-half with the Oliver Iron & Steel Company, Mr. Mohr had been with the Carnegie Steel Company continuously for 41 years. His first connection was at the Edgar Thomson Works as a messenger boy. Returning to the Carnegie Company in 1893 from the Oliver Iron & Steel Company, he was in the open hearth department at Homestead for two years, and then for five years was assistant chief chemist and later chief chemist at the Duquesne Works. He was chief chemist at Carrie furnaces from 1900 to 1902 and assistant superintendent from 1902 to 1905, when he was made superintendent. He was born in Germany 53 years ago, but came to this country with his parents when a boy. His widow, one son and four daughters survive him.

Mr. Mohr has been a contributor to this magazine: his annual review of blast furnace practice always reflecting his close knowledge of developments and tendencies.

THE SAFETY CRUSADE

(Concluded from page 407)

turing has other hazards—explosives used in quarries, the presence of powdered coal, used as fuel in most cement plants, and the molten stone from the kilns which is transported through the plants mechanically. Though it is generally overlooked, powdered coal is a dangerous explosive, and the fact that this is not generally recognized makes an added hazard. Despite the fact that the cement industry is more hazardous than many other industries, it has shown a material reduction of accidents. This demonstrates the efficacy of the contest.

Above all things, the cement companies have aimed to prevent carelessness, the most fruitful cause of accidents, and here the contest has aided greatly.

The POWER PLANT

Scientific Coal Storage

Summary of the Report of the Storage of Coal Committee of the American Engineering Council

DANGER of coal famine will be eliminated, industry stabilized, railroads relieved and the consumer's coal bill ultimately cut by seasonal storage of coal, it is asserted in the report of the storage of coal committee of the American Engineering Council made public recently.

"The storage of coal," the report declares, "is essentially necessary as an aid to the solution of the national coal problem, and is an economic and practicable means of insuring an adequate supply of coal as needed.

"If each coal consumer will adopt the policy of annually purchasing coal on a uniform monthly delivery basis, there will result automatically sufficient seasonal storage to guarantee coal to the consumer, as needed. Furthermore, this policy will bring about a uniform demand for coal whereby the coal producer and carrier may establish uniform and standard production and shipment schedules.

"It will also remove the evils of intermittent operation of coal mines, frequent panicky market conditions, and coal shortages due to inability of the carriers to meet peak demands."

Seasonal storage of coal by consumers, the committee finds, is an economic and practical means of insuring an adequate supply and satisfactory quality of coal when needed. "The irregularity in coal production," the report continues, "is largely due to seasonal demand. Since more coal is consumed in the late fall and in the winter than at other periods, coal producers and carriers each year are confronted alternately with a feast and a famine—with an inordinate demand for coal and transportation followed by a period of no demand. This seasonal demand is responsible for 47 per cent of the idle time of the coal industry."

Seasonal demand also contributes to another very disturbing element, namely, the overdevelopment of mine capacity through opening too many mines. Coal production capacity is now twice as large as the consumption capacity. The two factors—intermittent or seasonal operation and overdevelopment—are in a very large measure responsible for the ills of the coal industry."

The report, given out by Ex-Governor James Hartness of Vermont, president of the American Engineering Council, comprises about 110,000 words. It was prepared by a main committee of the council, headed by W. L. Abbott of Chicago, working with the Department of Commerce, the United States Coal Commission, and Federal, state and municipal agencies as well as private enterprise.

Sixty-seven sub-committees, functioning in every important industrial center in the United States, and comprising 400 individual engineers, constituted the field organization which carried on the nationwide survey for more than a year.

The report sets forth "a simple and practical remedy," saying that it is the coal consumer who must start the cycle that will bring about a stabilized industry.

"The amount of storage required to produce these corrective and constructive results," the committee declares in summarizing its conclusions, "is small in terms of the per cent of annual consumption. For seasonal storage, from 9 to 10 per cent of the annual consumption is all that is required. If this amount is supplemented by additional reserve storage of no more than 7 per cent, there will result an accumulation of some 83,000,000 tons of coal in storage by September 30 of each year. The practicability of this amount of storage with but slight additional outlay for equipment is indicated by the fact that in September, 1923, 56,000,000 tons were in storage.

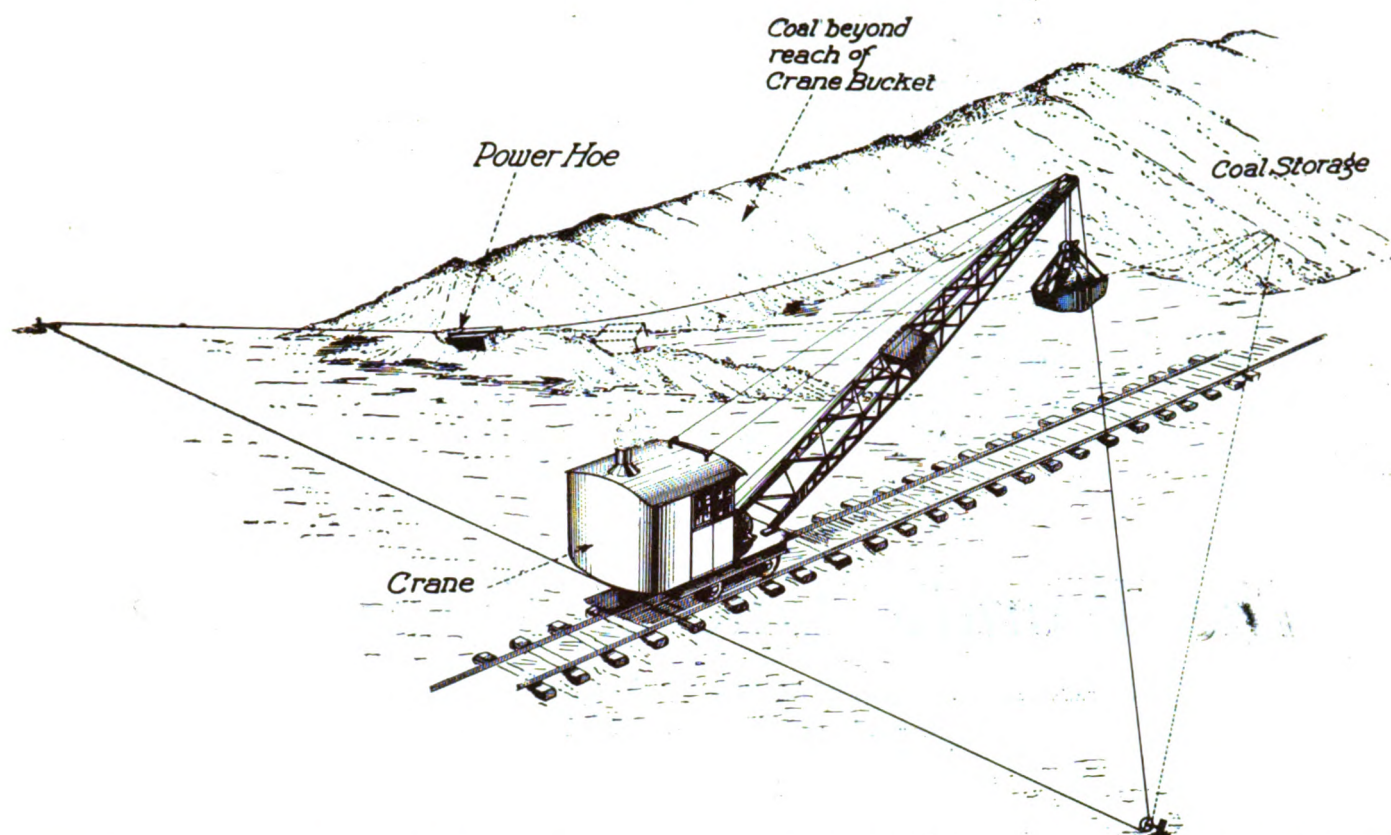
"Equipment has been developed and may be secured to meet any storage situation or requirement. The cost of such equipment ranges from a few cents per ton of capacity up to \$2.50 or \$3.00 per ton of capacity.

"Storage of coal presents no serious risk of loss from breakage, spontaneous combustion, or loss of heat value or firing qualities. All kinds of coal have been and may be successfully stored. The insignificant money loss due to the factors named above should not deter any one from storing coal. Application of the simple and inexpensive regulations and practices set forth in this report will provide all reasonable safeguards against such possible losses.

"The cost of storage per ton, including fixed charges on equipment, maintenance and operation expense and interest on investment in coal as well as taxes and insurance, in most instances does not exceed 75 cents per ton yearly. More generally it is around 50 cents per ton yearly. This cost is insignificant when distributed over annual consumption.

"Storing of coal may be easily financed. Banks will finance such an investment as readily as any other commercial undertaking.

"The transportation facilities in the United States are adequate for normal and regular movement of coal. For short periods the railways can move coal at an abnormal rate, but this is both expensive and detrimental to shipment or other commodities and to normal freight movement.



"To increase transportation facilities to meet the peak demands resulting from the prevailing unsystematic practice in coal shipment would require an additional investment of some \$12,000,000,000. Such an investment is not justified.

"The railroads have more to gain by storing coal than any other class of consumer. They should store their own coal on such a scale and at such times as to obviate the movement of company or non-revenue producing coal during the period when there is a heavy demand for the transportation of revenue producing freight. They should abandon, however, the uneconomic practice of using freight cars for storing coal and thereby withholding railroad equipment from other uses.

"In general, storage should take place at the point of use, to accomplish the most in relieving transportation and safeguarding supply. However, under some circumstances, storage-in-transit or at an intermediate point is advisable.

"In general, storage at mines is not recommended, but there should be sufficient mine storage facilities and capacity to overcome ordinary operating delays, such as belated arrival of cars, temporary breakdown or idleness of mining equipment and the like. Such provisions would materially increase the producing hours of mines and miners.

"Cars should be assigned to mines upon the basis of coal actually sold and not upon rated capacity of production. This measure would be a wholesome deterrent to overdevelopment of coal producing facilities.

"While this study refers primarily to industrial consumers of bituminous coal, yet householders have also a direct responsibility. Indeed the householder is in a position to aid with the least cost, because no special equipment for storing and reclaiming is required and his individual investment in coal is rela-

tively small. Householders use approximately 50,000,000 tons of bituminous coal annually, which, if placed in their bins by the end of September of each year would materially contribute to the solution of the coal problem.

"Federal, state, city and other civic divisions of the body politic are not meeting their responsibility in relation to the seasonal storage of coal. They are as derelict in regard to seasonal storage as are other users and frequently add to a confused situation by securing priority orders. Public officials should take the load, by precept and by example, in furthering the storage of coal.

"Contracts for coal should be observed with fidelity. The evil practice of indiscriminate breaking of coal contracts has seriously injured the American coal industry with reference alike to production, transportation and consumption. Contracts for coal should be observed with the same good faith as universally prevails in regard to other forms of commercial contracts.

"Confirmation of the practicability of coal storage is afforded by the anthracite coal industry. This industry is far more stable than the bituminous, because producers, carriers and consumers of anthracite coal for a number of years have alike encouraged and practiced storage."

The committee recommends that all coal consumers purchase their coal on an annual contract for yearly requirements with a provision that the coal be delivered monthly in equal allotments. It urges that consumers provide necessary storage facilities to meet the terms of such contract.

"These recommendations," the report points out, "are based upon the finding that the purchase of coal upon a uniform monthly delivery basis will result in a condition whereby coal mines may inaugurate and maintain a regular production schedule; carriers may plan definitely as regards both schedules and equip-

ment for a uniform movement of coal; stocks of coal automatically will accumulate during the months from April to September inclusive in sufficient amount to meet the extra consumption during the winter months; a reduction in the price of coal will be made possible by more regular schedules of production and transportation and by elimination of peak demands in the winter months when the costs of both production and transportation are the highest."

The committee reiterates, says the statement of findings given out by Ex-Governor Hartness, that the coal consumers through seasonally storing coal can and should initiate this vitally necessary cycle of changes.

The personnel of the committee of the American Engineering Council which conducted the investigation follows:

W. L. Abbott, chief operating engineer of the Commonwealth Edison Company of Chicago, chairman; H. Foster Bain, director of the Bureau of Mines, Washington; William Hutton Blauvelt, consulting engineer, New York City; W. H. Hoyt, chief engineer of Duluth, Missabe & Northern Railway Company, Duluth, Minn.; William J. Jenkins, vice president and general manager of the Consolidated Coal Company of St. Louis; David Moffat Myers, consulting engineer, New York City; Prof. S. W. Parr, University of Illinois, Urbana; Dean Perley F. Walker, University of Kansas, Lawrence; Roy V. Wright, editor of the "Railway Age Gazette," New York; Edgar S. Nethercut, secretary of the Western Society of Engineers, Chicago; O. P. Hood, U. S. Bureau of Mines, Washington.

The World's Largest Steam Boiler

Steam at 3,200 lbs. Pressure—A Radically Different Type
Generator Offering Possibilities

By A. C. BLACKALL*

IN England until quite recently the largest steam boilers in use were only able to evaporate about 90,000 lbs. of water per hour, but as regards capacity they are a great advance upon anything in the nature of steam generators to be found a generation ago. The boiler in vogue in many parts of the United States, of course, far eclipses British figures, as may be instanced by the Cleveland Electricity Company's boilers capable of evaporating 300,000 to 400,000 lbs. of water per hour, with a heating surface of three-fourths of an acre, while the Detroit Edison Company at Trenton has, I understand, boilers almost as large and has under consideration others able to deal hourly with an even greater quantity of water and to feed individually a 35,000-kv. turbine.

Even more astonishing, however, than the growth in size is the increase in pressure that marks modern boiler installation, and a comparison between American, British and Swedish figures is of considerable interest. Large power stations quite ordinarily use 350 lbs. pressure per square inch. At Chicago 550 lbs. is the figure adopted in the Crawford Avenue station, and we are given to understand that water tube boilers with drums having shells 4 inches thick and working at 1,200 lbs. are in course of construction. A Swedish engineer, M. Blomquist, has invented a boiler which works at 1,500 lbs. per square inch and which consists of a number of heavy steel tubes revolved at high speed to keep the water in contact with the interior of the tubes. But most remarkable of all is the boiler just constructed by the English Electric Company at Rugby which raises steam at a pressure of 3,200 lbs. per square inch. This is practically a "flash" boiler on a large scale. The steam generated will be reduced to a pressure of 1,500 lbs. for use in a turbine running at 25,000 rpm.

The new departure is so vastly in advance of anything previously in operation that it merits a special

description. It solves the practical difficulties involved in the generation of steam from water at the critical point. The "critical point," it should be noted, is that pressure (3,200 lbs. per square inch) and temperature (760 deg. F.) beyond which it is impossible for water to remain as water—it must immediately change into steam at the same density. Moreover, the total amount of heat is the same in the steam as in the water from which it has just been "generated," and therefore there is no latent heat involved in the transformation—a fact of extreme importance and significance.

Let it be admitted at once that there is no novelty in the idea of producing steam at this tremendous pressure. More than a hundred years ago, when steam above atmospheric pressure began to be used in the engines of the day, investigators and physicists were very much alive to the possibilities of high pressures and even high superheat. But there were insuperable difficulties in the way. At that time very little was known of the properties of metals to withstand great pressures and temperatures, and the art of mechanical engineering was in its infancy.

Practical men were content with the really remarkable results that they were able to obtain with low pressures, and even with steam far below atmospheric pressure. The separate condenser, the invention of James Watt, enabled engineers to utilize what will always be the most effective part of the steam expansion range, i. e., that part between 15 lbs. per square inch absolute, and the absolute zero or perfect vacuum. Watt was essentially a low pressure engineer, but even in his time there were other pioneers who were anxious to proceed to higher steam pressures. Among them was Richard Trevithick, who proposed to operate boilers at 60 pounds per square inch pressure. This "dangerous" proposal so perturbed Watt that he looked upon Trevithick as a "murderer." In recent years, however, materials and workmanship have been so greatly improved that the

*London, England.

generation and utilization of steam at its critical point have once more become matters not merely of theoretical and scientific interest, but of practical engineering possibility. The Swedes have the advantage of us in the possession of the purest iron ore in the world, which may have influenced the installation at the recent Stockholm Exhibition of a battery of boilers producing steam at 3,000 lbs. pressure per inch for driving the turbo-electric power plant.

Each boiler element consisted simply of a long coil of steel tube. The feed water was pumped in at the lower end by hydraulic pressure, and the steam was tapped at the other end through a non-return valve to the steam main. If, as sometimes happened, one of the boilers "burst," the only indication was that the pressure gauge had gone back; and the boiler was replaced by a spare element at the first convenient opportunity. It is noteworthy that there were no steel drums or other reservoirs, and the reason for this will appear hereinafter. The steam was used as it was produced, and produced only as it was needed. There was nothing to be gained by using the steam at full pressure in the turbines, and it was therefore allowed to expand down to about 1,000 lbs. per square inch. As a result, although the temperature dropped slightly, the steam was in a superheated and dried conditions before it entered the turbine.

Recently the problem has been tackled afresh by Dr. Benson and, as previously mentioned, his experimental super-pressure plant has been constructed at the Rugby (Eng.) works of the English Electric Company to investigate thoroughly all the features of the system. Only by actual experience can the questions of cost, efficiency, and suitability of materials be definitely settled. The primary and superheating coils are of carbon steel supplied by a continental concern of long and intimate association with metallurgical problems of this kind. Chrome nickel steel may possibly be used in future if found desirable.

The tubing of the primary coils, as also that of the superheater coils, is only 0.8 inch bore, the external diameters being 1.2 and 1.6 inches respectively. It will readily be appreciated that the choice of suitable materials is of the utmost importance. A pressure of 3,000 lbs. per square inch is not excessive in hydraulic and compressed air work, and temperatures of 700 to 800 deg. F. are quite usual in connection with Diesel engines. It is when these high pressures and temperatures are in combination in the same piece of apparatus that both material and workmanship become matter for anxious thought. Once the difficulties have been overcome (and with our present knowledge of metals and perfection of workmanship there seems no reason to doubt that they will be) we shall see some wonderful developments in steam practice, and the internal combustion engine will have to look to its laurels. It will also become a very doubtful question whether it is worth while following up the search for the so-called "gas-turbine," when a perfectly controllable medium such as steam at, for example, 2,000 lbs. pressure and 700 deg. F., is available in any quantity desired.

To revert to some of the phenomena accompanying the generation of steam at the critical point, the disappearance of latent heat should first be taken into consideration. One British thermal unit (Btu.) raises the temperature of one pound of water through 1 deg. F. When one pound of water begins to boil at atmospheric pressure its temperature is 212 deg. F.

To completely change the water into a pound of steam at atmospheric pressure, 966 Btu. must be absorbed; but the temperature is still only 212 deg. What has become of the heat? It's there right enough, but it is not recorded on the thermometer. Consequently it is said to be "latent," or lost to sight.

As a matter of fact, it has done an enormous amount of work. It has pushed the atmosphere back until the space occupied by the water has increased in volume by 1,600 times (approximately, one cubic inch of water produces a cubic foot of steam). The production of steam under familiar normal conditions as we know it, is always accompanied by a great increase in volume as compared with the water from which it has been generated, and it is also accompanied by ebullition more or less violent according to the rate of evaporation. In boilers, violent ebullition causes priming, which is mitigated somewhat by increasing the water surface to reduce the ebullition. Hence the reason for large boilers, or large steam drums in water-tube boilers. In the days of oscillating paddle engines, the dangers of priming were very great, particularly when the boilers were on the small side and had to be forced.

However, as boiler pressures increased and vertical engines were introduced, with the cylinders and steam pipes at a higher level, priming difficulties diminished. This was partly due to the fact that less heat is required to evaporate high pressure steam as the water reaches the higher boiling points. In other words, the "latent" heat is less, although the "sensible" heat (the heat required to bring the water up to the boiling point) is greater.

The relative figures for the sensible and latent heats are as follows:

At atmospheric pressure: 180 plus 970 equals 1,150 Btu.

At 67 lbs. per square inch (absolute) 374 plus 827 equals 1,179 Btu.

At 247 lbs. per square inch (absolute) 374 plus 827 equals 1,201 Btu.

It will be seen that the total heat increases very little as the pressure rises. At about 1,500 lbs. pressure it actually begins to decrease, and at the critical point—3,200 lbs. pressure—it is only 908 Btu. But at this point the latent heat has vanished entirely, and the figure 908 represents heat only. That is the amount of heat that has brought the water at 3,200 lbs. pressure up to the boiling point, and no additional (i. e., "latent") heat is needed to convert it entirely into steam. But that is not strictly and literally correct. Precisely what happens is this: The slightest addition of heat instantly converts the whole mass of water into steam without any increase of volume or change of density.

At one moment the boiler coils are full of water at 3,200 lbs. pressure per square inch and 706 deg. F. The next moment it is all steam at the same pressure and temperature. Hence no steam drum or reservoir is necessary, as there is no increase in volume. It is, in the most literal sense, a flash boiler. All that is wanted is a hydraulic pump to feed the cold water into the coils and a fire to heat the water in the coils to the desired temperature; and a steady flow of steam without ebullition or priming is the result.

In actual practice, however, it naturally is not always such plain sailing; otherwise we should have had the "critical point" flash boiler in general use

years ago. As stated, it is largely a matter of finding the right material, namely, a steel which, when drawn into tubing, will withstand the high temperature of generation and superheat, in combination with the enormous pressure; and which will, moreover, last for a reasonable time in service.

However, it should be mentioned that the danger resulting from explosion is practically nil. At Stockholm, all that happened when a coil split or burned out was that the boiler ceased to function, and was replaced by a spare. The amount of water or steam in each element was only a few pints and was soon dissipated when a tube failed. Similarly, there is lit-

tle danger with a split tube in any water-tube boiler. The firedoors and dampers close automatically with an increase in pressure in the furnace, and the forced draught carries the escaping steam up the funnel until the boiler can be isolated.

The safe generation of steam at the critical point will give rise to far-reaching developments in engineering practice, especially in steam turbines. Although it may be some time before it affects marine work, land power station experts throughout the universe are even now keenly interested—and there are no keener engineers than those in charge of the huge electrical undertakings of the present day.

*New Measuring Device for the Recording of CO₂ and CO Based on Physical Properties**

By R. DUENCKEL

IN 1920 there was described in this journal a CO₂ recorder based on certain properties. The scope of this instrument has been extended so that CO as well as CO₂ can be recorded in flue gases.

The efficiency of a boiler installation depends on the temperature drop between the combustion chamber and the last heat absorbing element be that boiler, feed water heater or waste heat boiler. It is desirable to obtain not only all the heat available from the fuel, but to obtain the highest possible initial temperature in order to increase the available heat. Flue gas analysis permits the determination of an excess or deficiency in air, and also whether under certain circumstances unburned gases may not escape even in the presence of excess air. The CO₂ content of flue gases is a measure of the excess air. The importance of CO content is recognized but has not been recorded nearly so frequently as CO₂ because of the lack of suitable practical instruments. CO is a product of incomplete combustion due either to deficiency in air or to too rapid cooling of the products of combustion even in the presence of excess air. Both causes, of course, seldom occur in the same plant during any relatively short period.

With correct operation steaming coals yield 14 to 16 per cent CO₂, lignite 16 to 18 per cent without any CO. The new double recording instrument operates correctly under all plant conditions even if there is a large and long continued deficiency of air.

The working principle is founded on the difference in resistance to flow of a gas which exists in a capillary and an ordinary tube. The resistance to flow in the capillary depends on the viscosity, while in the ordinary tube it depends on the density. The properties are completely independent and characteristic for each gas. CO₂ shows a smaller resistance than air to flow through a capillary, but a larger resistance to flow through a tube. The differential drop of flue gas compared to that of air is proportional to the CO₂ content, is indicated by a manometer and is recorded. In the case of CO the ratio of viscosity to density is

practically the same as that of air. This permits the correct registering of CO₂ even in the presence of CO. The CO is then burned by means of copper oxide. Each volume of CO is converted to one volume of CO₂, so that no changes in composition except the replacement of each volume of CO by an equal volume of CO₂. If now CO₂ is recorded the increase in CO₂ is a measure of the percentage of CO present. By means of a differential manometer which records the pressure drop due to ordinary flue gas in which the CO is converted to CO₂ by copper oxide the percentage of CO present is indicated and recorded.

The apparatus is comparatively simple. The flue gas to be tested first passes through a dust filter. The supply line branches into three lines. The first is connected with a capillary tube parallel to a tube through which air flows. Both the flue gas and the air are connected to the opposite arms of a circular manometer. The difference in level is recorded by a simple registering device as the CO₂ content. The second branch flows through another capillary, while the third branch is arranged so that gas passes through a small electrically heated furnace containing copper oxide before it passes through a third capillary which is set parallel to the second capillary. These two capillaries connect with the opposite arms of a circular manometer, the difference in level of which is recorded as CO on an ordinary recording cylinder. All four capillaries (one for air, two for unchanged flue gas and the other for oxidized flue gas) lead into one line which is connected to a pump which draws off the gases at a constant suction.

If the flue gas contains CO₂ only the first cylinder records the correct value for it while the second cylinder registers zero for the CO content. But if CO is also present both cylinders show a record, the first for the actual CO₂ present, the other for the CO present. The current consumption of the electric furnace does not exceed 50 watts and the supply of copper oxide is such that in the complete absence of air on an eight-hour run it can still completely burn 4 per cent CO to CO₂ completely. Of course, this is

*Das Gas-und Wasserfach, April 12, 1924, pages 197-199. Abstracted by Albert P. Sachs, Technical Director, Universal Trade Press Syndicate.)

(Concluded on page 426)

Electrical Cleaning of Blast Furnaces Gases

By N. H. GELLERT*

TWO things may be wasted in a blast furnace gas—the gas itself and the dust which it contains. Mr. A. E. Maccoun in his paper, "Blast Furnace Advancement," some years ago stated that, during one test made by him, a little over 200 pounds of flue dust was produced per ton of iron made. In the production of 40,000,000 tons of iron per year, therefore, about 4,000,000 tons of flue dust will be made.

How much of this is being wasted it is hard to say; for dust caught is in the cyclone dust catchers, the mains, the combustion chambers and the brickwork. And many plants already have gas-cleaning systems. But waste there is; and with the waste there is nuisance.

This four million tons of flue dust has a real value, for its iron content is often greater than that of the ore itself. Fortunately one need not emphasize this point to blast furnace men, for the strenuous post-war period has awakened a national consciousness to the elimination of needless waste.

Last year, upward of 40,000,000 tons of iron was produced by the blast furnaces of this country. At least an equal amount of coke, if not a greater amount, was consumed in the production of this quantity of iron. Forty million tons of coke were charged into the blast furnaces of the United States. What may be the cost of this coke is problematical, but if we assume an average price of \$5 a ton, which is probably low, then we are astounded by the fact that \$200,000,000 worth of coke was used in producing the iron of this country during the last year. The average blast furnace operators knows, of course, that only half of the coke burden is actually consumed in the furnace. The other half is emitted from the top of the furnace in the form of blast furnace gas. Therefore, of the coke which was charged into the blast furnaces of this country, \$100,000,000 worth was burned in the furnace and another hundred million dollars worth was burned in auxiliary equipment.

Yet the care and attention which the first \$100,000,000 worth received was infinitely greater than the care and attention which the second \$100,000,000 worth received, although they were brothers and not first cousins. Peculiarly enough, it is much easier to conserve that part of the coke which issues in the form of gas than the portion which is consumed in the blast furnace proper.

The blast furnace operator has a definite grip on his blast furnace gas during every minute of the day. But the care and attention which other fuels demand are not required by blast furnace gas; for once properly cleaned and when burned in the correct type of burners it will yield its maximum possible thermal value with less irregularity than any solid or liquid fuel.

During the year of 1922, according to the American Gas Journal of December 29, 1923, the manufactured gas which was sold in the United States amounted to

*President, Gellert Engineering Company, Philadelphia, Pa. Paper read before the joint meeting of the Eastern States Blast Furnace and Coke Oven Association of Chicago District, June 5, 1924, Cleveland, Ohio.

488,813,860 M cubic feet, and had a total value of \$337,116,805. In the absence of more authoritative figures, we may assume the average heat value of this gas to have been 500 Btu. per cubic foot.

During 1923, if we accept 140,000 cubic feet of blast furnace gas per ton of iron as a fairly average figure, there was produced about 5,600,000,000 M cubic feet of blast furnace gas, to which we may give a heating value of 90 Btu. per cubic foot.

There was consequently $11\frac{1}{2}$ times as much gas produced by the blast furnaces than by the gas manufacturing plants which sold their product to the public. And the gas that came from the blast furnaces had a unit heat value of a little less than two-tenths of the unit heat value of so-called manufactured gas. This means that the heat value of the blast furnace gas produced was a little over twice as great as that of all the manufactured gas sold in the United States. Yet the value placed upon it is less than one-third of that for which the manufactured gas was sold; or in other words, the blast furnace operator was allowed to buy his gaseous heat units for one-sixth the cost to those who used manufactured gas.

Let this point be fixed in our minds—that the blast furnace gas industry, in quantity of gaseous heat units developed, is twice as large as the entire manufactured gas industry of the country.

This is the size of the responsibility of the blast furnace operator. To him must we look for the proper utilization of this vast source of energy.

The operator who is allowing his gas to leak unnecessarily, or who is not securing the maximum efficiency from the combustion of his gases in the hot stoves or boilers is as guilty of deliberate waste as the operator who throws a part of his coke pile into the dump.

Before any dry-cleaning methods were devised, blast furnace operators were using uncleaned gas or else gas cleaned by some wet system.

No matter how controversial the subject of hot dirty gas versus wet clean gas may have been years ago, no modern furnace operator holds any brief for dirty gas, for its wastefulness is self-apparent. The blast furnace operator who is burning dirty gas in his hot stoves or boilers is not only using this most valuable fuel inefficiently but is accelerating the destruction of his auxiliary equipment. The combustion chambers of his stoves are being filled with dust; the checker brick is being fluxed with alkaline material and its refractory nature is being destroyed by the glaze which this reaction produces. In comparatively short periods of time the brickwork is destroyed and rechecking is made necessary. The boiler tubes are coated with dust, and are insulated by the coating, so that the transfer of heat from the hot burning gases to the water in the boiler is being greatly retarded.

Notwithstanding the damage which this dirty gas does during its passage through the boilers and stoves, it discharges into the atmosphere the products of combustion laden with a burden of dirt and fume, and fills the air with millions of particles that eventually must settle on the surrounding neighborhood.

But all blast furnace operators are convinced of the necessity of cleaning blast furnace gas. Even the wet method of cleaning gives results that make the use of dirty gas inexcusable. Yet there are certain inherent objections to wet cleaners which the majority of blast furnace men have had, and which cannot readily be overcome. There are five attendant difficulties in cleaning gas by a wet method.

A large water supply is required. In order to clean the gas that comes from a 500-ton furnace there is needed 2,000,000 gallons and upwards of water per day. This necessitates an ample water supply and a large pumping equipment. The blast furnace operator who says that he has all the water that is necessary and that pumping costs him nothing or very little because he has excess gas or steam, is simply fooling himself. Nothing is obtained for nothing. To pump 2,000,000 gallons of water requires a considerable amount of power and when this power is consumed for pumping it cannot be used for anything else.

Mr. George M. Rohl in his paper on the cleaning of blast furnace gas at the last session of the American Iron & Steel Institute made the statement that wet cleaners required .04 kw. for pumping the water required to clean 1,000 cubic feet of gas. This means that 5.6 kw. per ton of iron are used for pumping water.

In localities where water is exceedingly scarce, and there are many such places, wet washers create a demand that is difficult to take care of, and often results in the too economical use of water and the resultant inefficiency of the cleaner.

But even when there is plenty of water and the gas is satisfactorily washed, there still remains the problem of getting rid of the water with all the dirt and sludge which it has removed from the gas. To discharge 2,000,000 gallons of dirty water into a stream is possible in some localities simply because the community has not become sufficiently irritated at the nuisance. We must all look this issue of stream pollution squarely in the face, for in every community there is constant agitation which must eventually result in the passage of stricter laws and a stricter enforcement of the laws now existing. To deliberately and unnecessarily pollute a stream is wrong, whether it is done by an industrial concern or by a private individual; and it is only a matter of time before it will be impossible for any industry to discharge an effluent into any stream when that effluent is harmful to either fish or bacterial life, or when it causes a nuisance because of its unhealthful or dirty nature.

Many of the plants which have already installed wet washers have found it necessary to make additional installations of auxiliary equipment in order to remove the sludge from the effluent. Before the effluent can be made clear not only thickeners and settling basins have been found necessary, but also continuous filters. Only with the use of such a complete equipment has it been possible to produce a clear effluent which, up to the present time, has not proven objectionable. But this involves the use of other equipment than a cleaner and necessitates the operation of filters which come under the line of chemical equipment and results in greater labor charges as well as maintenance costs.

Another feature of wet washing is the objectionable entrainment of mechanical moisture. When a

wet washer operates efficiently and reduces the temperature of the gas to below 80 deg. F., its moisture of saturation is exceedingly small. The figures which are usually given are the theoretical calculations; but many of the wet washers, perhaps most of them, entrain moisture mechanically and carry this moisture through the mains to the hot stoves and boilers.

In an admirable discussion of Mr. Hohl's paper on "Cleaning Blast Furnace Gas," Mr. J. C. Barrett commented on this phase of wet cleaning.

In his statement he said that gas which was washed by wet cleaners often caused the residual dust, after the gas had passed through the cleaner, to bake in both the hot stoves and boilers.

On the boiler tubes this wet dust formed a very hard crust which it was difficult to remove by any ordinary methods of blowing. In the hot stove combustion chambers it built up into a solid hard mass and also deposited as a crust on the top of the checkers.

The condition is much aggravated when the cleaner is not operating at its maximum efficiency and the gases are not cooled down sufficiently. For as the temperature of the washed gas is increased, its absorption of moisture is greater, and the dust is naturally wetter. But this is not the only objection to moisture, for each particle of water requires the use of heat to bring it up to the flame temperature of the gas, and consequently the heat developed for this purpose is not available for useful work.

The paradox of wet cleaning is that it must rob the gas of its sensible heat in order to give it the greatest efficiency in combustion. At the last meeting of the American Iron & Steel Institute, Mr. Hohl stated that Richards & Johnson estimated 11 to 12 per cent of the total heat of the gas to be in the form of sensible heat, while later experiments by Joseph, Royster & Kinney gave 10 to 12 per cent as the sensible heat of the gas.

If reference is again made to the \$100,000,000 worth of coke which comes out of a blast furnace in the form of gas, and the figures as quoted by Mr. Hohl are accepted as correct, then from \$10,000,000 to \$12,000,000 worth of coke is in the form of sensible heat. This is what wet washing aims to waste in order to the greatest efficiency from the remaining \$90,000,000 worth of coke.

While a blast furnace operator would look with a great deal of disfavor on a 10 per cent dilution of his blast furnace gas, with some inert material like nitrogen or carbon dioxide, he often accepts without discussion the necessary evil of losing 10 per cent of the heat of his gas by cooling his hot gases to the required degree found necessary in wet washing.

Not only are the total figures for the industry impressive, but the figures which show what is going on at an individual furnace are sufficiently important to merit serious consideration.

In a paper delivered by Mr. H. A. Brassert before the American Iron & Steel Institute in 1914, he submitted several formulae for the calculating of the Btu. per cubic foot of blast furnace gas, the cubic feet of gas made per ton of iron and other interesting data. By means of these formulae there has been developed for the discussion tonight some data based on a coke rate of 2,000 pounds per ton of iron at a furnace which has a capacity of 500 tons per day.

According to Mr. Brassert's formulae, the gas which comes from such a furnace will have a latent heat of combustion of 95.4 Btu. per cubic foot. There will be made 142,000 cubic feet of gas per ton of iron. This gas will have an equivalent latent heat value of 13,500,000 Btu. per ton of iron.

But these figures do not include the sensible heat of the gas. In a paper which the speaker presented some time ago, a typical example was worked out to determine the amount of sensible heat which was present in a gas having a temperature of 400 deg. F., since this temperature approximated the actual conditions at many of the blast furnaces.

In the calculation of the specific heats of the constituent gases, the formulae of Richards were used. Since that time a great deal of study has been made of the data which has now been published on specific heats, and the results of this study are now made available to the public in curves presented for the first time. Many of the formulae surpass those of Richards in accuracy and should it be necessary to secure the closest possible information, it would be advisable to use some of the formulae which have been recommended. But for the work which we are considering today and the results of which are more or less approximate, the data developed previously will hold.

If we consider gas with an average composition as follows:

Carbon Dioxide.....	12.5 per cent
Carbon Monoxide.....	24.5 per cent
Hydrogen	3.5 per cent
Nitrogen	58.6 per cent

Having a moisture content of 35 grains per cubic foot, then we find that the sensible heat amounts to approximately 18½ Btu. per cubic foot at a temperature of 400 deg. This means that for every ton of iron made, there is present in the gas a sensible heat value of 1,200,000 Btu. Every ton of iron, therefore, is paralleled by the production of gas with a heat value of 14,700,000 Btu., or every minute there comes from the blast furnace, in the form of gas, a heat value of 5,099,000 Btu.

To make it easy to calculate the Btu. value for a furnace of any capacity, the term ton-minute is devised. The gas per ton-minute is that amount of gas which is given off by the furnace during every minute for every rated ton of daily capacity.

According to these calculations, 10,198 Btu. exists in the blast furnace gas per ton-minute.

Accepting the heat value of coke as 14,500 Btu. per pound, it may be seen that 1,020 pounds of coke is the equivalent of the gas which is produced per ton of iron. This means that in a 500-ton furnace with a 2,000-pound coke rate, 351 pounds of coke are consumed every minute in the form of gas. The equivalent of the sensible heat in the gas is 80 pounds of coke per ton of iron. The question, therefore, before the blast furnace operator is clearly this: Shall he make use of these 80 pounds of coke or shall he, literally, throw them away?

The sensible heat of a gas is no less valuable than its equivalent in latent heat.

Because of all these objections to wet washing the whole blast furnace industry has encouraged and looked with favor on every step in the development of systems which tend to clean gas by dry methods. Electricity has eliminated from the problem of clean-

ing gases every one of these objectionable features. There is no water required in cleaning gas by electricity for less current than is necessary to operate the pumps and the auxiliary equipment when water is being used can be applied directly to the individual molecules of the gas, and act directly on each particle of dust and thereby secure the direct precipitation of the dirt from the gas. There is no sludge problem, because the dust is recovered in its dry form and can be handled in its dry state, and has a value not unlike that of the original ore which is charged into the blast furnace. There is no danger of the pollution of streams for there is nothing to discharge into the river.

With the electrical cleaning of gas there is no mechanical moisture entrainment; there is no necessity for the operation of an expensive and laborious auxiliary equipment, and most important of all, there is no loss in sensible heat.

Because there is no entrainment of mechanical moisture, residual dust is deposited in a flocculent instead of in a hardened state. The speaker quotes again from Mr. Barrett's paper as follows:

In the discussion of Mr. Barrett which has already been referred to, he stated that gas cleaned by a dry method did not cause any deposition of a hard material, but that the dust deposited from such a dry clean gas was collected in a flocculent manner on the tubes of the boilers and in the checker brick of the stoves and was consequently very easily removed by blowing the dust off both tubes and checkers.

Since, therefore, the electrical cleaning of gas has eliminated all of the problems that have made wet cleaning objectionable, it is worth while considering this method seriously.

The standard unit consists of a cylindrical shell nearly 9 feet in diameter and some 30 feet high, and is filled with vertical pipes, 90 in number, each 6 inches in diameter and 10 feet long. Through the center of each pipe is suspended a wire to which is furnished the high tension electrical current which causes precipitation. The gas enters underneath a header plate and travels around the outside of the pipes and up through the electrified zone in the pipes and out through the upper part of the precipitator.

As the gas goes through the electrified zone, each particle of gas is ionized, and consequently each particle of dust and fume is electrified. Because of its electrification it is driven to the sides of the pipe, where it is held by the corona discharge from the wire. This discharge may be distinguished by the purple glow around the wire which is clearly seen when one looks up into the pipes. The action is not magnetic. It is electrolytic.

Particles of non-metallic material are as easily and as quickly precipitated to the sides of the pipe as metallic particles. The action takes place in an extremely short while as the velocity through the pipes is at the rate of between 10 and 13 feet a second, and consequently the gas is within the pipe for approximately one second. There is no resistance to the flow of gas other than that caused by the natural bends through which the gas must travel since the cross sectional area of the pipes is greater than the cross sectional area of the main, which feeds the precipitator. No additional burden is therefore placed on the blowing engines and the pressure is no more greatly decreased than through an equal number of bends and length of main.

When a precipitator has been running for a period of 30 minutes to an hour and the pipes are coated with dust, the unit automatically cut off and the pipes are automatically rapped and the dust drops to the bottom hopper, from which it may be discharged at will, preferably every 12 hours. As soon as the pipes have been rapped, the unit is automatically cut in again and precipitation continues. In a plant which handles the gas from a 500-ton furnace and which contains approximately eight precipitation units, only one-eighth of the plant is out for rapping at any given time.

In a case where a slip occurs and large amounts of dust are consequently precipitated in a very short period of time, a button on the switchboard enables the operator to throw in the whole cycle of action between the regular rapping periods, and consequently rap the pipes at will. The whole equipment is interlocked with safety devices so that no one can enter the cage containing the high-tension equipment without immediately cutting off the current from that particular cage.

With a plant of such simple nature, the maintenance cost is extremely low. The precipitator shell with its pipes, structural work and wires has no movement and consequently contains nothing to wear out. The operating motors are small, none of them over 2-hp., so that they present no problems other than that usually presented by motors of this size. Tips of the mechanical rectifier will wear out in the course of six months, but are replaced in a very few minutes time at a cost of a few cents apiece.

There is no other cleaning plant that requires so little attention and has such a small maintenance expense attached to it. The operating cost of a precipitation plant is exceedingly small, for the entire current consumption required in a 500-ton furnace plant is not over 50 kw. and the labor is taken care of by one attendant per shift.

The results obtained have been satisfactory in all three if the installations on blast furnaces. Exact tests made at Colorado have shown that gas can be cleaned to a little over one-tenth of a grain per cubic foot, and even in cases of heavy slips when 10 grains of dust per cubic foot are present in the inlet gases can be cleaned to one-half a grain per cubic foot. But the greatest proof of the value of cleaning gas electrically is seen by the actual results obtained in the hot stoves and boilers. In tests that have been made on hot stove efficiency there has been an increase of efficiency in the stove of 33 1-3 per cent when using gas that has been cleaned electrically instead of dirty gas. A saving of over 30 per cent in gas consumed in a stove has been recorded on such tests, and with the same gas consumption, it has been possible to increase the blast temperature from 100 to 200 deg.

Stoves have not fouled up, dust has not baked in the combustion chambers and as a whole the gas has burned with a flame that has been sharp and clear.

The Colorado installation, on which work is now being done, will be the largest of its kind yet built and will have every automatic feature that has been mentioned. Eventually it is planned to extend it to include the third furnace so that a battery of 24 units will take care of the whole plant.

From the results obtained at Colorado it is calculated that approximately 80 tons of flue dust will be recovered in the precipitators from the two furnaces,

the value of which, since the dust runs 50 per cent in iron, will not only pay for the operation of the cleaning plant but will give a profit of \$30 per furnace per day.

Here is the development of an idea that eliminates a nuisance both to the public and to the blast furnace operator and converts it into money for his use. It is estimated by the engineers of the Colorado company that the total economies effected by this cleaning plant will enable them to pay for the entire cost of the installation in one year. While this is an unusual condition, it may be said that the cleaning of gases by electricity will provide such economies that a plant can be paid for out of the economies in two years if no previous plant exists at the furnace, and in four years if a dry cleaning plant is substituted for wet cleaners.

It has often been contended that the cost of a dry cleaning system is greater than that of a wet cleaning system and on this basis several furnaces decided to install wet cleaners. This is obviously a fallacy, for when wet cleaners are installed to accomplish the cleaning of the gas and the recovery of the sludge and the prevention of the sludge nuisance in a stream, their cost is no less than that of dry cleaning plants.

These, then, are the facts with regard to the dry cleaning of blast furnace gases. Yet in the estimate of savings to be obtained by its use, no figures can be justly given to show those intangible benefits which accrue, and the valuation of which must remain in the realm of conjecture. No dollar value can be placed on the elimination of the smoke and stream pollution nuisance, yet in the long run it is bound to reflect itself in monetary value somewhere along the line of industrial costs. No estimate outside of pure guess can be made of the benefits to be obtained by eliminating the troubles of supersaturated gases, of mechanical moisture, of baking dust, of the fuss and worry about sludge recovery.

Ten million dollars worth of sensible heat in the blast furnace gases of the country demand each year an attention which they have not yet secured. Shall this heat not only be wasted but utilized in the creation of a nuisance, and lend itself to the development of a source of worry, or shall it be conserved to aid, penny by penny, in the present industrial fight for stabilized business conditions?

New Measuring Device

(Continued from page 422)

an extreme case which could not occur in normal boiler practice.

The problem of determining CO₂ and CO simultaneously is thus simply solved and the equipment records their percentage continuously and distinct from each other even though a single strip of recording paper may be used. In fact this last condition leads to a clear comparative diagram with both percentages arranged alongside of each other.

The Northern Indiana Gas & Electric Company have placed another contract for the remodeling of their two 6-ft. sets at the Lafayette Station, with The U. G. I. Contracting Company.

Steel Treaters Convention

THE Sixth Annual Convention of the American Society for Steel Treating to be held at Commonwealth Pier, Boston, September 22 to 26, like all previous conventions, will be the largest ever held by the society.

The ever increasing growth of the society and the interest displayed at Pittsburgh last year, would indicate that a few years hence, the annual convention and exhibition will surpass anything of its kind ever held in this country.

The increasing popularity of previous conventions would indicate that this year's gathering will tax the capacity of Commonwealth Pier in spite of the fact that the space to be occupied by exhibits will be almost double that of the Pittsburgh convention. It will occupy 150,000 square feet of Commonwealth Pier. Extensive preparations are being made at the pier for the reception of the exhibits, indications at present pointing to the largest attendance of any convention ever held.

There are 200 exhibitors, 30 of them representing the steel makers, 30 representing all types of furnaces, while some 70 machine and machine tool builders have reserved space. Over 1,000 h.p. will be required to work the display.

Annual Meeting.

The annual meeting of the American Society for Steel Treating will be held in the ball room at the Copley Plaza Hotel on Wednesday morning at 9:30 A. M. Dr. George K. Burgess, chairman. The national committees of the society will present their reports at this meeting.

The plan carried out last year at Pittsburgh of holding technical sessions from 9:30 in the morning until 12:00 will be followed again this year. There will be but one technical session a day, and this session will be held in the ballroom of the Copley Plaza Hotel. The exposition will not open in the morning on Monday, Tuesday and Wednesday, but will open at 1:00 o'clock. However, on Thursday and Friday, the exposition will be open at 10:00 o'clock in the morning.

This arrangement will assist in eliminating the long hours for the exhibitors and also give them an opportunity to attend technical sessions in the morning. However, due to the large number of papers that have been presented, it will be necessary to hold short technical sessions, and round table discussions in the afternoons. These meetings will be held in the meeting room, located at Commonwealth Pier, and undoubtedly will be very largely attended.

Noted Engineers to Attend.

Professor Kotaro Honda, one of the most brilliant metallurgists in the world has notified the American Society for Steel Treating that he will be present at their annual convention and steel exposition. Professor Honda has prepared a paper which will be read at the Wednesday morning session. It is also possible that an event may be arranged so that Professor Honda may meet some of the prominent metallurgists of this country in attendance at the convention. Information has been received that Doctors Bulle and Bleibtreu of the German Iron and Steel Institute will be present.



Hotel Copley Plaza, headquarters for the Sixth Annual Convention, American Society for Steel Treating.

TENTATIVE PROGRAM

Sixth Annual Convention

AMERICAN SOCIETY FOR STEEL TREATING

Boston, September 22-26, 1924

Note: Registration begins at 1 P. M. at Registration Desk, Commonwealth Pier

MONDAY, SEPTEMBER 22

Morning Session

- Meeting in Ball Room, Copley Plaza Hotel.
10:00—Address of Welcome—Maj. James M. Curley.
Welcome by Boston Chapter—V. O. Homerberg.
Address of Welcome—A. O. Fulton, General Chairman.
Response—President George K. Burgess.

Technical Session

- Chairman—Dr. George K. Burgess.
"The Nature of the Function of Chromium in High Speed Steel," E. C. Bain and M. A. Grossman, Atlas Steel Corporation.
"The Use of Cobalt and Vanadium as Additions to High Speed Steel," Dr. W. Oertel and Dr. ing. F. Poelzgueter, Germany. (By title).
"Magnetic Determination of the Elastic State," A. V. deForest, American Chain Company.
"The Law of Depression of Freezing Point as Applied to Metallic Alloys," Kotaro Honda and Toyato Ishigaki, Imperial University, Japan. (By title).

Afternoon Session

- 1:00—Exposition opens.
2:30—Technical Session, Meeting Room, Commonwealth Pier.
Chairman—A. H. d'Arcambal.
Symposium on Salt Baths as Heating Media.
"Heat Treatment in Salt Baths," Maj. A. E. Bellis, Bellis Heat Treating Company.
"Salt Baths," Sam Tour, Doehler Die Castings Company.
"Fused Salt Baths for the Prevention of Soft Spots in Quenched High Carbon and Carburized Steels," W. J. Merten, Westinghouse Electric & Manufacturing Company.

Evening Session

- 7:00—Moving Pictures.
Exposition open until 10:00 P. M.

TUESDAY, SEPTEMBER 23

Morning Session

- Meeting in Ball Room, Copley Plaza Hotel.
9:30—Technical Session.
Chairman—Dr. John A. Mathews.
"Density and X-Ray Spectrum of Hardened Ball Steel Drawn at Various Temperatures," K. Heindlhofer and F. L. Wright, SKF Industries, Inc.
"The Application of X-Ray Crystal Analysis to Metallurgy," Dr. W. P. Davey, General Electric Company.
"Spheroidizing Cementite in Hypoeutectoid Steel," R. S. MacPherran and J. Fletcher Harper, Allis-Chalmers Mfg. Company.
"A New Method of Interpreting Notched Bar Impact Test Results," Dr. ing. Max Moser, Essen, Germany. (By title).
"A Laboratory Method for the Preparation of Small Steel Bars Differing Only in Carbon Content and the Effect of Changes in Carbide Concentration on the Specific Resistance," E. C. Campbell, University of Michigan, and G. W. Whitney, American Smelting & Refining Company. (By title).
"The Microstructure of Austenite and Martensite," F. F. Lucas, Western Electric Company.

Afternoon Session

- 1:00—Exposition opens.
1:30—"Plant Visitation, Thomas G. Plant (Manufacturer of Queen Quality Shoes), or Waltham Watch Company.
2:30—Technical Session, Meeting Room, Commonwealth Pier.
Chairman—Prof. H. M. Boylston.
"The Intrinsic Value of Heat Sources versus the Floating Economic Value of the Btu.," E. F. Collins, General Electric Company.
"Selection of Fuel for the Heat Treatment of Metal," J. A. Doyle, W. S. Rockwell Company.
"Gas as a Factor in Improving Quality Standards and Lowering Production Costs of Heat Treated Steel," H. O. Loebell, Combustion Utilities Company.

Evening Session

- 7:00—Moving Pictures.
9:30—Annual Smoker and Entertainment, Ball Room, Copley Plaza Hotel.
Exposition open until 10:00 P. M.

WEDNESDAY, SEPTEMBER 24

Morning Session

- Meeting in Ball Room, Copley Plaza Hotel.
9:30—Annual Meeting of the American Society for Steel Treating.
Chairman—Dr. George K. Burgess.
Report of Chapter Delegates.
"Alloy Steels," Dr. John A. Mathews, Crucible Steel Company of America.
"Some Fundamental Factors for Obtaining Sharp Thermal Curves," Carl Benedicks, K. G. Lund and W. H. Dearden, Stockholm, Sweden. (By title).
"Granulation Hypothesis and the Delta-Gamma Change in Iron, Carbon and Nickel Alloys," Colonel N. T. Belaiew. (By title).

- "Strain Endurance of Metals," W. J. McAdams, Jr., Naval Experimental Station, Annapolis.
"On the Transformation in Pure Iron," Kotaro Honda, Imperial University, Japan.

Afternoon Session

- 1:00—Exposition opens.
1:30—Plant Visitation, General Electric Company, Lynn, or Naumkeag Manufacturing Company, Salem (Textile Material).
2:30—Technical Session, Meeting Room, Commonwealth Pier.
Chairman—Colonel A. E. White.
"The Heat Treatment of Automobile Parts," J. M. Watson, Hupp Motor Car Company. (Illustrated with a motion picture).
"Die Records and Their Effects on Die Costs," E. J. P. Fisher, R. Wallace & Sons Company.
"Heat Treatment of Tool Steel," F. C. A. H. Lantsberry, Jessop Steel Company, Sheffield, England.
"Progress in the Manufacture and Use of Clay Refractories," W. G. Owen, Haws Refractories Company.

Evening Session

- 7:00—Moving Pictures.
Exposition open until 10:00 P. M.

THURSDAY, SEPTEMBER 25

Morning Session

- Exposition opens at 10:00 A. M.
Meeting in Ball Room, Copley Plaza Hotel.
9:30—Technical Session.
Chairman—Dr. Albert Sauveur.
"Quenching Diagrams for Carbon Steels in Relation to Some Quenching Media for Heat Treatment," H. J. French and O. Z. Klopsch, Bureau of Standards.
"A New Theory of Overstrain and Strength of Materials," H. P. Trendly and G. V. Pickwell, Wm. D. Gibson Company.
"X-Ray Tests Applied to the Problems of the Steel Foundry," Dr. H. H. Lester, Watertown Arsenal.
"Influence of the Structure 'as cast' upon the Manufacture and Qualities of Some Alloyed, Especially High Speed Steels," Dr. ing. Franz Rapatz, Dusseldorf, Germany. (By title).
"The Effect of Various Reductions in Forging Upon the physical Properties of Steel," D. J. McAdams, Jr., U. S. Naval Experimental Station, Annapolis.

Afternoon Session

- Technical Session, Meeting Room, Commonwealth Pier.
"Hardness Testing Symposium, National Research Council, Dr. H. P. Hollnagel, chairman.
"Comparison of Brinell and Rockwell Hardness of Hardened High Speed Steel," S. C. Spalding, Halcomb Steel Company.
"The Relation of Hardness and Impact Measurements to Performance," G. W. Webster, Bellis Heat Treating Company.
"Relation Between Rockwell and Brinell Hardness Scales," Irving H. Cowdrey, Massachusetts Institute of Technology.
"The Ball Indentation Hardness Test," S. L. Hoyt, General Electric Company.
"Report on Hardness Testing Work of A. S. M. E. Committee on Cutting Metals," Maj. A. E. Bellis, Bellis Heat Treating Company.

- 5:30—Exposition closes.

Evening Session

- 6:30—Annual Banquet and Dinner Dance of the American Society for Steel Treating, Ball Room, Copley Plaza Hotel. Tickets at Registration Desk.

FRIDAY, SEPTEMBER 26

Morning Session

- Exposition opens at 10:00 A. M.
9:30—Technical Session, Ball Room, Copley Plaza Hotel.
Chairman—Dr. Zay Jeffries.
"Stainless Iron and Steel," T. Holland Nelson, United Alloy Steel Corporation.
"Stainless Steel and Stainless Iron," O. K. Parmiter, Firth-Sterling Steel Company.
"Tensile Properties of Some Steel Wire at Liquid Air Temperatures," W. P. Sykes, National Lamp Works of General Electric Company.
"Grain Boundaries in Steel," Cecil H. Desch, England. (By title).
"Macroscopic Examination of Steel," V. O. Homerberg, Massachusetts Institute of Technology.

Afternoon Session

- 1:30—Tour through Harvard University, Massachusetts Institute of Technology and Navy Yard.
2:30—Technical Session, Meeting Room, Commonwealth Pier.
Symposium on Metallurgical Education.
Chairman—Dr. O. E. Harder.
"Metallurgical Education," Bradley Stoughton, Lehigh University.
"On Metallurgical Education," S. L. Hoyt, General Electric Company.
Paper—Prof. D. J. Demarest, Ohio State University.

Evening Session

- 7:00—Band Concert.
10:00—Exposition officially closes.

Boston Trading Center of New England

The metropolitan district of Boston forms a powerful economic unit, the natural center for the manufacturing and trading interests of New England.

BOSTON as a commercial and industrial center is a city of 1,657,000 rather than a city of only 748,000. The real Boston extends far beyond the municipal boundaries. There is no break in the widening circle of stores, warehouses and factories which are thickly spread over the whole area of Metropolitan Boston. The 40 towns and cities, whose economic interests are inextricably bound up with the banking and railroad and port facilities of their center, comprise the real Boston. This Metropolitan District forms a powerful economic unit, the natural center for the manufacturing and trading interests of New England, one of the richest industrial regions of the world.

The Metropolitan District.

Thirteen of the municipalities each manufacture annually goods valued at over \$10,000,000, and nine more than \$20,000,000 each. Below the \$10,000,000 line, among the smaller communities which are chiefly residential in character, are 12 each of which turn out over a million dollars' worth of goods annually, the amount ranging from a little over \$1,000,000 to more than \$9,500,000. In the three cities of Metropolitan Boston which are next to Municipal Boston in industrial importance, more than \$255,000,000 are invested in manufacturing plants and machinery, and the aggregate output of these establishments amounts to more than \$388,000,000 a year.

Great Variety of Products.

Ranging from copper, tin and sheet iron work, the value of which amounts to \$11,503,642 a year to boots and shoes, including cut stock and findings, valued at \$205,653,423 a year, the industrial products of Metropolitan Boston amounting to an annual value of over \$11,000,000 each are: gas, knit goods, woolen and worsted goods, furniture, patent medicines and druggists' preparations, coffee and spice, roasting and grinding, soap, cutlery and tools, leather, bread and other bakery products, foundry and machine shop products, electrical machinery, apparatus and supplies, clothing, confectionery and ice cream, rubber goods, including rubber boots and shoes, printing and publishing, slaughtering and meat packing.

Shoe and Leather Center of the World.

Boston is the center of the largest and most concentrated shoe manufacturing industry in the world, with an immense co-ordinated tanning industry and a great variety of kindred manufacturers.

New England today (principally the states of Massachusetts, Maine and New Hampshire) produces one-half of the footwear made in the 1300 factories in the United States and worn by the country's 110,000,000 men, women and children. In 1919, Massachusetts alone produced enough shoes for every man, woman and child in Porto Rico, Canada and the United States to have a pair. Massachusetts manufacturers about twice the value of shoes turned out by

its next rival and almost a third more than the combined total of its two nearest rivals.

Boston is also a great import and export center for the shoe and leather industries. A single shipment of Argentine hides recently unloaded in Boston was estimated to furnish sole leather for 1,000,000 pairs of shoes.

Headquarters of Cotton Manufacturing.

Boston is the center of the most important cotton manufacturing district in the United States. Located here are the executive offices of many of the great cotton mills of New England, the national organization of cotton manufacturers and, of course, a large number of cotton brokerage houses and warehouses. It is, moreover, the greatest American port of entry for Egyptian cotton.

Greatest Wool Market of the United States.

From the beginning of manufacturing in the United States, Boston has held unquestioned position as the first wool market in the country. The wool importers and distributors feed more than 200 manufacturing establishments in Massachusetts alone. Their annual product was valued by the last federal census at more than \$343,000,000. Massachusetts mills turn out about a third of the wool goods of the country and New England more than half.

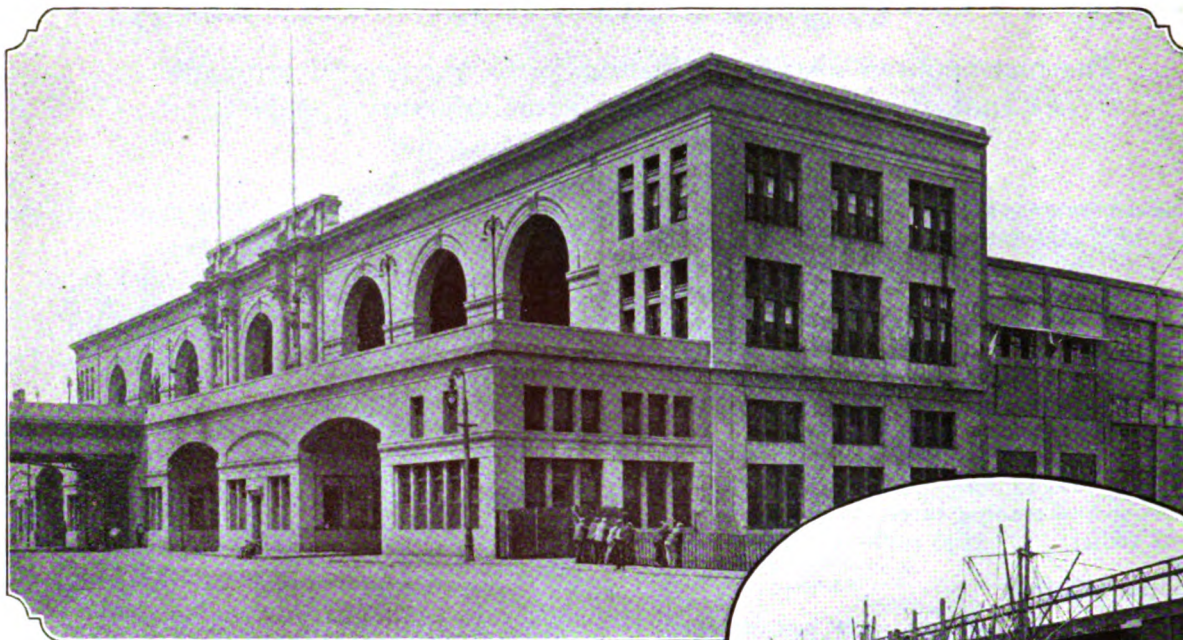
A Pioneer in Light and Power Development.

Boston was one of the first cities in the world to make extensive use of electricity for motor power. In 1886 the first station was established in Boston. The following year the Edison Company was supplying current for 92 motors with an aggregate of 300 hp. In South Boston today, an area of more than 24 acres is required for a generating station, coal storage and equipment. An average of approximately 1,000 tons of coal a day are consumed under the boilers of this plant.

From the streams of New England it is theoretically possible to develop for 3,000 hours of every year approximately 15,000,000 hp., the equivalent of 50,000,000 tons of coal annually. While at the present time it may not be practical or economical to utilize more than a relatively small percentage of this theoretical energy, it is feasible to produce in New England as a whole from 1,000,000 to 1,500,000 hp. of this energy.

The Metal Trades.

New England has always been noted for the high quality of its metal products. It is natural that those manufactured in this district are chiefly small articles requiring a high degree of skill and workmanship. In the Metropolitan District 277 foundries and machine shops turn out an annual product amounting to more than \$55,500,000. Tools and cutlery from 55 factories add \$18,000,000 more to the annual output of metal products.



LIST OF EXHIBITORS AT COMMONWEALTH PIER

Name	Booth No.	Name	Booth No.	Name	Booth No.
Abrasive Machine Tool Co.	C-205	Firth-Sterling Steel Co.	B-135 and 145	New Engd Asn of Gas Eng.	B-137 and 147
Acme Machine Tool Co.	C-221	Fitchburg Machine Works.	C-250	New England Tool & Annealing Co.	A- 48
Adams & Durkee Steel Co., Inc.	A- 55	Ford Co., J. B.	A- 25	Nuttall Co., R. D.	B-142
Air Reduction Sales Co.	B-134 and 144	Forging, Stamping, Heating Treating	A- 35	Ohio Machine Tool Co.	C-213
American Gas Furnace Co.	A-9-10	Ganschow Co., Wm.	A- 49	Ohio Steel Foundry Co.	B- 96
American Machinist.	C-247	General Alloys Co.	A-12-22	Olsen Testing Machine Co., Tinius.	A- 64
American Tool Works.	C-237	General Electric Co.	B-90-91	Oxweld Acetylene Co.	A- 65
American Twist Drill and Tool Co.	B-161	General Weld & Equipment Co.	B-149	Pangborn Corporation.	B-151-152-163-164
Andresen & Associates, F. C.	B-159	Geometric Tool Co.	C-208	Peerless Machine Co.	C-248
Armstrong-Blum Manufacturing Co.	B-139	Gisholt Machine Co.	C-197	Pennsylvania Pump & Compressor Co.	B-153
Armstrong Cork & Insulation Co.	B-131	Goddard & Goddard Co.	B-167	Penton Publishing Co.	A- 33
Atkins & Co., Inc., E. C.	B-112	Goss & DeLeeuw Machine Co.	C-221	Pittsburgh Crucible Steel Co.	A- 51
Atlas Steel Co.	B-168	Gould & Eberhard, Inc.	C-221	Potter & Johnson Machine Co.	C-242
Avey Drilling Machine Co.	C-221	Gunn Mfg. Co.	B-143	Pratt & Whitney.	C-196
Baker Brothers.	C-221	Hagan Co., George J.	B-108	Prentiss Co., Henry.	C-221 and 235
Barber Colman Co.	C-201-202	Halcomb Steel Co.	A- 50	Racine Tool & Machine Co.	C-215
Bath & Co., Inc., John.	A- 37	Hauck Manufacturing Co.	A- 54	Republic Flow Meters Co.	A- 26
Bausch & Lomb Optical Co.	A- 45	Hayes, C. I.	B-102	Rivett Lathe & Grinder Corp.	C-207
Bay State Tap & Die Co.	B-175	Heald Machine Co.	C-209	Rockwell Co., W. S.	A- 30
Bellevue Industrial Furnace Co.	A- 53	Heim Grinder Co.	C-252	Rodman Chemical Co.	A- 34
Bellis Heat Treating Co.	A- 6	Hendey Machine Co.	C-241	Roessler & Hasslacher Chemical Co.	A- 58
Bethlehem Steel Co.	A-36-37	Heppenstall Forge & Knife Co.	A- 57	Ryan & Co., F. J.	A- 17
Blanchard Machine Co.	C-221	High Speed Hammer Co.	C-204	Shore Instrument & Mfg. Co.	B-169
Bristol Co.	B-99-100	Hoskins Manufacturing Co.	B-115	Simonds Saw & Steel Co.	B-127-128
Brown Lynch Scott Co.	B-128	Houghton & Co., E. F.	A- 63	Spencer Turbine Co.	A- 7
Brown Instrument Co.	B-132	Hunt Steel Co., A. E.	B-171-A	Sly Mfg. Co., W. W.	B-155 to 156
Brown & Sharpe Mfg. Co.	C-218-19	Hunter Saw & Machine Co.	B-137-A	Stromberg Electric Co.	B-133
Bureau of Standards.	B-176	Illingworth Steel Co., John.	B-118	Surface Combustion Co.	A-15-16
Calorizing Co.	A-21-28	Industrial Gas Equipment Co.	A- 5	Swedish Crucible Steel Co.	A- 1
Campbell Co., Inc., A. C.	C-237	International Nickel Co.	A-13-23	Tacony Steel Co.	B-162
Carborundum Co.	A- 18	Iron Age Publishing Co.	A- 60	Thompson Electric Welding Co.	B- 97
Carpenter Steel Co.	B-150	Jessop & Sons, Inc., Wm.	B-171-B	Thompson Co., Henry G.	C-221
Case Hardening Service Co.	A- 29	Jones & Lamson Mach Co.	C-211 and 217	United Alloy Steel Corporation.	A-31-32
Celite Products Co.	A- 11	Jones & Laughlin Steel Corp.	A- 44	Union Twist Drill Co.	C-216
Central Steel Co.	B-126-138	Kardex Co.	B-174	V. & O. Press Co.	C-221
Cincinnati Bickford Machine Co.	C-221	Keller Mechanical Engin. Corp.	C-221	Vanadium-Alloys Steel Co.	A- 62
Cincinnati Milling Machine Co.	C-221	Keystone Lubricating Co.	A- 24	Vanadium Corp. of America.	A- 67
Cincinnati Planer Co.	C-221	King Refractories Co., Inc.	A- 38	Vulcan Crucible Steel Co.	B-172
Cleveland Twist Drill Co.	C-246	Leeds & Northrup Co.	B-101 and 114	Walcott Lathe Co.	C-214
Cochran-Bly Co.	C-237	Leitz, Inc., E.	A- 56	Walker Co., O. S.	C-221
Colonial Steel Co.	A- 43	Lewis-Shepard Co.	B-116	Wallace & Sons Mfg. Co., R.	B-173
Cooper-Hewitt Co.	C-203	Lodge & Shipley Machine Tool Co.	C-221	Ward's Sons Co., Edgar T.	A- 42
Crucible Steel Co. of America.	A-39-40-41	Ludlum Steel Co.	B-148 and 160	Warner & Swasey Co.	C-228-236
Davidson Gas Brnr & Wdg Co., N. C.	A- 8	Lynd-Farquhar Co.	C-237 and 245	Westinghouse Elec. & Mfg. Co.	B-94-95
Dearborn Chemical Co.	A- 61	McDonald & Co., P. F.	B-107	Wetherell Brothers Co.	B-154
Disston & Sons, Inc., Henry.	B-122	Midvale Co.	B-141	Wheelock Lovejoy & Co., Inc.	A- 27
Driver-Harris Co.	A- 59	Moline Tool Co.	C-221	Whitehead Metal Products Co.	B-136
Dyest Steel Co.	C-210	Monarch Machine Tool Co.	C-237	Wilmarth-Marmon Co.	C-237
Eaton-Electric Furnace Co.	B-125	National Automatic Tool Co.	C-221	Wilson-Maeulen Co.	B-129-130
Engelhard, Inc., Charles.	A- 66	National Electric Light Assn.	B- 93	Wolff Gas Radiator Co., A. H.	A- 14
Federal Machine & Welder Co.	B- 92				

SHEET ^{AND} TIN PLATE

Pickling of Iron and Steel; A Bibliography

1—General and Miscellaneous. 2—Machines and Equipment. 3—Pickling in Acid Solutions. 4—Pickling in Salt Solutions. 5—Electrolytic Pickling. 6—Inhibitors and Accelerators. 7—Effect of Pickling. 8—Recovery of Spent Liquors.

Compiled by VICTOR S. POLANSKY*

PART III

Marino, Pascal. Electrolysis. (British Patent, 20,180 of 1912.)

Marino, Pascal. Electrolytic Process for Removing Oxid or Rust. (United States Patent, 1,195,704.)

Metal to be cleaned is made the cathode in an electrolytic circuit, in solution of sulphate and fluorid of sodium, potassium or magnesium.

Marino, Quintin. Electrolytic Method of Cleaning Iron and Steel. (United States Patent, 1,324,317.)

Consists in making the iron to be cleaned the cathode in a solution containing a soluble sulphate and a soluble fluorid.

Nistler, George W. Electrochemical Concentration of Liquids. (United States Patent, 896,749.)

Payne, Arthur. Method of Cleansing Molds. (United States Patent, 1,430,844.)

Electro-chemical process of removing scale from iron, which consists in immersing the iron in an electrolyte in contact with a metallic plate higher in the electrochemical series than iron.

Reed, C. J. Electrolytic Pickling of Steel. 1907. (In Transactions of the American Electrochemical Society, v. 11, p. 181-184.)

The same, abstract. 1908. (In Iron Trade Review, v. 42, p. 422.)

Method of removing magnetic oxid of iron by making the metal the cathode in a sulphuric acid bath.

Reed, Charles J. Process of Electrolytically Dissolving Iron Oxide Scale. (United States Patent, 827,179.)

Reed, Charles J. Process of Electrolytically Removing Scale and Producing Iron Sulfate. (United States Patent, 827,180.)

Reed, Charles J. Process of Electrolytically Removing Scale and Producing Iron Sulfate. (United States Patent, 855,667.)

Revillon, L. Un Nouveau Procédé de Décapage et D'Oxydation Galvaniques des Métatux. 1919. (In Revue de Métallurgie, v. 16, Mémoires, p. 257-268.)

An electrolytic method of cleaning steel and other metals, using sodium ferrite as the electrolytic agent.

Scott, E. Kilburn. Economy of Acids in Metal Trades. 1917. (In Journal of the Society of Chemical Industry, v. 36, pt. 2, p. 810-814.)

Brief discussion of electrolytic pickling, p. 813-814.

Thompson, C. H. Electrolysis. (British Patent, 3,374 of 1912.)

Electrolytic pickling of metals in a chlorid, a sulphate or a nitrate.

*Carnegie Library of Pittsburgh.

Thompson, M. DeKay, and Dodson, F. W. Electrolytic Pickling of Steel. 1917. (In Metallurgical and Chemical Engineering, v. 17, p. 713-714.)

Experiments on the effect of chemical and electrolytic pickling on black sheet iron and transformer sheet iron containing silicon.

Thompson, M. DeKay, and Mahlman, O. L. Electrolytic Pickling of Steel. 1917. (In Transactions of the American Electrochemical Society, v. 31, p. 181-189.)

The same, abstract. 1917. (In Iron Age, v. 99, pt. 2, p. 1190-1191.)

The same, abstract. 1917. (In Iron and Coal Trades Review, v. 97, p. 690.)

The same, abstract. 1917. (In Iron Trade Review, v. 61, p. 1375-1376.)

The same, abstract. 1917. (In Journal of the Franklin Institute, v. 183, p. 797.)

The same, abstract. 1917. (In Metallurgical and Chemical Engineering, v. 16, p. 586-587.)

Investigation of the relative efficiencies of the electrolytic and the chemical processes of pickling steel.

Inhibitors and Accelerators.

Addy, Mathew, Co. Picklette; Acid Saver and Beneficiating Agent. 31 p. [1924.]

Contains a brief discussion of pickling, and numerous useful tables.

Aiken, Benjamin F., and Others. Wire or Metal Cleaning Bath. (United States Patent, 288,150.)

Relates to the addition of metallic cyanide to pickling solution, which increases the efficiency of the acid bath.

American Chemical Paint Company. Pickling Made Efficient with Rodine Extract. 46 p. 1924. (Bulletin No. 15.)

Deals with the chemistry involved in pickling and shows photomicrographs of surfaces under various conditions of treatment.

Beneker, Jay C. Wire and Metal Cleaning Bath. (United States Patent, 914,916.)

By adding a small amount of arsenic to the dilute acid, the action is limited to the solution of the scale and the metal is but slightly attacked.

British and Foreign Chemical Producers, Ltd. Pickling. (British Patent, 158,768.)

To avoid brittleness in iron or iron alloys, organic bases, especially quinoline nucleus, are added to a pickling bath.

Burgess, Charles F. Some Observations on the Influence of Arsenic in Pickling Solutions. 1905. (In Transactions of the American Electrochemical Society, v. 8, p. 165-170.)

"Commercial" Rust Remover and Pickling Compound. 1922. (In *American Machinist*, v. 57, p. 825.)

Foreign preparation used for rust removal from metals, as well as in sulphuric acid baths for pickling purposes.

Compound for Control of Acid Fume in Pickling. 1921. (In *Forging and Heat Treating*, v. 7, p. 421.)

Developed by Hoffman Process Company, Pittsburgh.

Crabbe, Henry J. Pickling Compound. (United States Patent, 1,268,818.)

Mixture for making pickling solutions for treating castings or other metal articles, is composed of sodium chlorid, 1 part and sodium acid sulphate, 2.5 parts.

Emlen, George W. Improvement in Pickling. 1922. (In *Iron Age*, v. 109, p. 813.)

New compound developed which retards acid attack on sound metals.

Griffin, Roger C. The Solubility of Metals in Acids Containing Formaldehyde. 1920. (In *Journal of Industrial and Engineering Chemistry*, v. 12, p. 1159-1160.)

Deals with the use of hydrochloric acid containing 1 per cent of formaldehyde, which secures pickling of rusty steel without any effect on the steel itself.

Hoffman, Addison F., and Parkin, W. M. Process of Pickling Metal Articles. (United States patent, 1,221,735.)

Neutralized waste sulphite liquor is added to an acid to form a blanket of foam on the liquor and prevent the escape of acid spray.

Holmes, Harry N. Removal of Scale and Rust from Iron and Steel. (United States Patent, 1,470,225.)

Iron or steel is pickled in a bath of sulphuric acid containing 0.2 per cent aldehyde, to inhibit the attack of the acid on the metal.

Mechanism and Efficiency of Restrainers. 1923. (In *Chemical Trade Journal and Chemical Engineer*, v. 73, p. 34-35.)

Abstract from the "Alkali Inspectors Report" for 1922. Presents experimental data on the comparative efficiencies of pickle-ette acid, tragon, gelatin and cresol acid as restrainers in pickling of tin-plate.

Meurice, Albert. Sur le Décapage en Tréfilerie. 1896. (In *Bulletin de l'Association Belge des Chimistes*, v. 9, p. 343-358.)

The same, abstract translation. 1896. (In *Journal of the Society of Chemical Industry*, v. 15, p. 454-455.)

The same, abstract translation. 1903. (In *Metal Industry*, U. S., v. 1, p. 114.)

States that arsenic may be advantageous to an acid pickle, since when present in suitable proportion it reduces the consumption of acid while increasing the effectiveness of its work.

New Pickling Compound. 1922. (In *Metal Industry*, U. S., v. 20, p. 403.)

"Sumfoam" compound, said to protect cleaned metal from action of the acid after scale removal.

"Picklelette." 1920. (In *Iron and Coal Trades Review*, v. 101, p. 763.)

Brief description of a new pickling mixture.

Robinson, Chauncy E., and Sutherland, William L. Composition for Polishing Metal Bars, Plates, Sheets, Etc. (United States Patent, 640,491.)

Rustproofing Syndicate, Ltd. Pickling Metals. (British Patent, 163,868.)

Bath for pickling ferrous metals, which attacks the scale portions only and has no detrimental effect on the metals.

Substitute for Sulphuric Acid in Pickling. 1915. (In *Iron Age*, v. 96, pt. 2, p. 1519.)

A compound perfected by the Research Manufacturing Company, Oak Lane Station, Philadelphia, is applied to iron, steel, brass, copper, etc.

Effect of Pickling.

Baedecker. Versuche Ueber das Verbeizen von Stahl- und Eisendraht. 1888. (In *Zeitschrift des Vereines Deutscher Ingenieure*, v. 32, pt. 1, p. 186-188.)

Investigation on the absorption of hydrogen by pickled iron and steel wire. Tabulates results.

Baker, Herbert A., and Lang, W. R. Deteriorating Effect of "Acid Pickle" on Steel Rods and Their Partial Restoration on "Baking." 1906. (In *Journal of the Society of Chemical Industry*, v. 25, pt. 2, p. 1179-1180.)

The same. 1907. (In *Journal of the Chemical, Metallurgical and Mining Society of South Africa*, v. 7, p. 424-425.)

Cause of deterioration is believed to be due to the formation of a hydrid of iron. Gives results of investigation.

Burgess, Charles F. Action of Acid on Iron and of the Use of the Acid Pickle. 1905. (In *Electrochemical and Metallurgical Industry*, v. 3, p. 332-335, 384-386.)

The same, abstract. 1905. (In *Engineering News*, v. 54, p. 352-353.)

The same, abstract. 1905. (In *Iron Age*, v. 76, p. 801-803.)

Burgess, Charles F. Injurious Effect of Acid Pickles on Steel. 1906. (In *Electrochemical and Metallurgical Industry*, v. 4, p. 7-11.)

States that the brittleness or "rotting" of iron and steel is due to the penetration of hydrogen rather than of the acid. Gives methods and results of investigation.

Burges, Charles F., and Engle, S. G. Observations on the Corrosion of Iron by Acid. 1906. (In *Transactions of the American Electrochemical Society*, v. 9, p. 199-210.)

Gives results of experiments on the effect of dilute acids on iron.

Carpenter, R. C. Heat Transmission Through Cast-iron Plates Pickled in Nitric Acid. 1890. (In *Transactions of the American Society of Mechanical Engineers*, v. 12, p. 174-186.)

Presents method and results of investigation.

Chemistry of Pickling Baths. 1918. (In *Automotive Industries*, v. 39, p. 960-961.)

Discusses the action of acids, effect of the strength of bath, temperature effect, and the organic and inorganic materials modifying the action of the bath.

Conroy, James T. Rate of Dissolution of Iron in Hydrochloric Acid. 1901. (In *Journal of the Society of Chemical Industry*, v. 20, p. 316-320.)

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Relates to the regeneration of spent liquor by oxidation with air and manganese dioxid or other manganese compounds.

Hoffman, Addison F. Process of Pickling Iron and Steel. (United States Patent, 1,146,071.)

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Hoffman, Addison F., and Parkin, W. M. Recovering Values from Pickling Metals. (United States patent, 1,269,441.)

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Howl, E., and Perry, F. Sulphuric Acid Recovery from Waste Pickling Solutions. (British Patent, 5,830 of 1915.)

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Parker, Thomas. Improvements in the Utilization of Waste or Spent Acid Pickle from Galvanizing Works. (British Patent, 24,859 of 1894.)

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Ramage, A. S. Utilizing Spent Pickle Liquor. (United States Patent, 788,064.)

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Deals briefly with the recovery of spent pickle liquor, p. 813.

Shaw, Joseph A. Process of Reclaiming Spent Pickling Solutions. (United States Patent, 1,384,974.)

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Investigation at Shelby, Ohio, gives some methods of recovery.

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Waste Pickle in Galvanizing, Etc., Works. 1892. (In Journal of the Society of Chemical Industry, v. 11, p. 682-683.)

Brief treatment of the recovery of pickling liquors.

Weaver, A. T., and Others. Methods of and Apparatus for Treating Waste Pickle Liquor. (United States Patent, 1,348,462.)

Relates to the recovery of iron oxid.

A complete index to the 45 volumes of the Transactions of the American Society of Mechanical Engineers will be issued during October. The general style of the Engineering Index Annual has been followed, all items being grouped alphabetically under authors' names and subjects. Particular attention has been paid to Volumes 26 through 45 (those since 1905), with the idea of bringing to light the great store of hitherto unindexed material hidden in discussions and in the papers themselves. The items have also been very fully cross-referenced. The work will prove a key to the valuable literature of mechanical engineering.

Trade Notes and Personals

Sanford Riley Buys Harrington Stoker

Believing that the Harrington Stoker represents the best machine of its type on the market today, the Sanford Riley Stoker Company has taken over the entire business of the United Machine & Manufacturing Company of Canton, O. From now on the business of the United Machine & Manufacturing Company will be handled in the name of the Sanford Riley Stoker Company. The head office of the company will be at Worcester, Mass., with plants at Worcester, Mass., Detroit, Mich., and Canton, O. The consolidation of these two companies will result in the most complete line of underfeed, overfeed and chain grate stokers ever brought together under one head. With Riley, Jones, Murphy and Harrington Stokers to choose from, it will be possible to handle any solid fuel from the highest grade semi-bituminous down to the poorest grades of culm, lignite, anthracite screenings, coke breeze, refuse, etc. This consolidation makes available to the stoker-buying trade the combined engineering and manufacturing talent of the two companies, and it will be possible to offer a type of stoker suitable for every possible combustion need. Mosher Separators as heretofore made by the United Machine & Manufacturing Company will be manufactured and sold by the A. W. Cash Company, Decatur, Ill., manufacturers of boiler specialties and combustion control. The A. W. Cash Company is a subsidiary of the Sanford Riley Stoker Company.

Storing and Handling Core Oil

Foundries have not had the advantage of as many time and labor saving devices as have been invented for work in other industries. This, no doubt, is largely due to the fact that foundry work does not offer the opportunity. We were pleased to learn, however, of an easier and more efficient way for handling core oil, which is of interest to all foundries.

The outfit consists of a steel tank into which core oil is transferred when received. The tank is equipped with a measuring pump so that the desired quantity of core oil can be accurately delivered. The tank may be located convenient to the mixers, saving many steps back and forth. There is no slopping and spilling, as the exact amount of oil is drawn with each mix.

In addition to the economy, there is greater efficiency because of this accuracy resulting in stronger cores and clearer castings with less chance of imperfections which otherwise occur. Where emulsion is used an extra tank may be installed equipped with water line and also an air line, the latter being used for the purpose of mixing.

With this arrangement the operator merely opens the valves for the desired amount of water, accurately measures the required quantity of oil, and then opens the valve on the air line which agitates it into a thorough emulsion. This affords a decided saving in oil, time and labor over the old method for those foundries using emulsion.

Where core oil is purchased in large quantities or tank car-lots, underground storage may be provided,

which saves space. A long distance pump is located in the mixing room, or core making department, which is connected to the underground tank.

Alfred Kauffman was recently elected president of the Link-Belt Company, Chicago, manufacturer of conveying equipment, to succeed Charles Piez, now chairman of the board. He has been connected with the company for 24 years. Mr. Kauffman was born in 1879 and was educated at Rutherford, N. J. At the age of 15 he became an apprentice in the tool room of the General Electric Company at Schenectady, N. Y., later joining Robert Hoe & Company, builder of printing presses. Following three years of apprenticeship there he entered Pratt Institute, Brooklyn, N. Y., from which he was graduated in 1901. Mr. Kauffman then became connected with the Link-Belt Company, holding the position of draftsman until August, 1906. He was appointed assistant to the superintendent of construction and a year later became superintendent. In 1909 he was appointed sales engineer in the West Virginia territory and in 1913 as assistant to the president. In that year he was appointed manager of the company with office in Philadelphia, having charge of eastern operations. In the next year he was advanced to manager of the company's Indianapolis plants and in February, 1915, was appointed vice president and general manager of those plants. From this position he was elected president July 24, 1924. Mr. Kauffman is a member of the executive committee of the Indianapolis branch of the National Metal Trades Association and is active in other industrial and social clubs in that city.

In line with their established program for expansion, the Sloss-Sheffield Company of Birmingham recently accorded the Link-Belt Company of Chicago an order for a gondola car dumper. This dumper will be similar to that installed at the Cahokia power station, East St. Louis.

The new machine will be required to dump gondola cars of coal (of a capacity including 100 tons) at the rate of 20 an hour. The Link-Belt gondola car dumper is distinctive in that only a 19-hp. motor and one man is required for its operation.

Jay M. Amsden, who has been superintendent of the Hanna docks at Ashtabula, O., has been made general superintendent of all the Hanna Dock interests, including the Ohio & Western Pennsylvania Dock Company and the Lower Lakes Dock Company, operating docks at Sandusky, Cleveland and Ashtabula, O., and Erie, Pa.

Back from Europe, where he visited England and Continental countries, Charles S. Robinson, vice president and general manager Youngstown Sheet & Tube Company, Youngstown, declares conditions are apparently growing better. Mr. Robinson states that Great Britain is encountering great difficulties in connection with the payment of unemployment doles, many of the unemployed being disinclined to return to work, as the amount they would earn is little in excess of what they receive in doles.

President Eugene G. Grace of the Bethlehem Steel Corporation returned last week from a month's vacation trip to England.

WITH THE EQUIPMENT MANUFACTURERS

REMARKABLE DIESEL ENGINE

An entirely new design of two-cycle, double-acting Diesel engine, believed to represent the greatest advance in the art yet made in America, and expected to mark an epoch in the development of internal combustion power machinery throughout the world, was announced here today by the Worthington Pump & Machinery Corporation. The new engine combines a fuel economy comparable with that of the best existing types of Diesel engine, with dimensions, weight and construction cost per hp. approaching those of reciprocating steam machinery.

Another striking and important feature of the design is the fact that the hp. per cylinder can from all indications be carried to a far higher value than any yet attained in Diesel engines, thus immensely increasing the field of possible usefulness of Diesel-type power, and making it an active competitor of steam power machinery over a much wider range than has before been possible. The first unit built in the Buffalo plant of the Worthington corporation, is very conservatively rated at 600 to 800 hp. for a single cylinder unit, at speeds of 90 to 120 revolutions per minute.

The new Worthington engine was wholly designed and built in America, and owes nothing to European patents or ideas developed abroad. Behind it is the Worthington company's 24 years of experience in building internal combustion engines, culminating in nearly four years of intensive research, study and experiment aimed directly at the production of the result which has now been attained in the new engine.

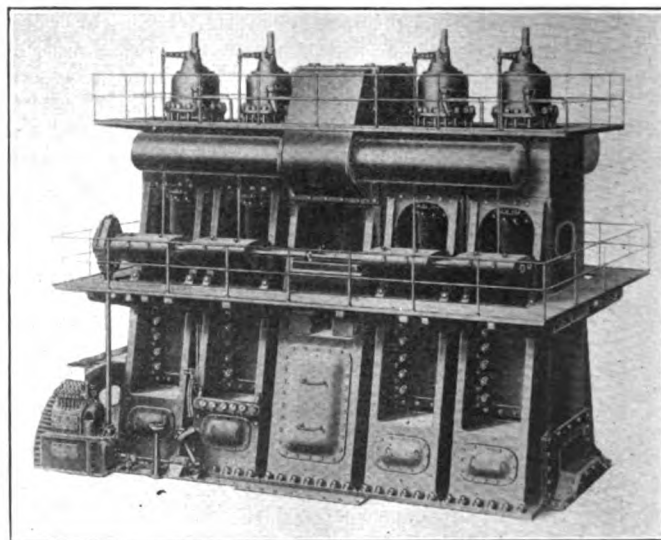
The Worthington corporation has been a leader in American Diesel engine production since 1912, in which year the first wholly American design of engine of this type was developed in the company's Buffalo shops. Nearly 100,000 hp. of Worthington Diesel engines are now in active service in the United States. The Worthington type of gas engine has been known since 1900, and over a quarter of a million hp. of such engines, including the largest double-acting gas engines ever built, are now in use.

The immediate inspiration behind the research campaign which has now put the company in the forefront not only of American, but of world practice in this type of power machinery, was the known need of an improved Diesel engine for ship propulsion. It is common knowledge that for the past five years, the problem of disposal of the United States war-built merchant fleet, which is the major portion of the entire problem of the American merchant marine, has defied solution. Its difficulties have been two:

First, the fact that under existing American laws, and with American standards of wages, subsistence and equipment, the differential in operating costs against the American vessel in competition with those of other countries has been sufficient, in times of low ocean freight rates such as have prevailed for the past few years, to drive the American vessel out of the market.

Second, the fact that as a result of its war program, the U. S. Shipping Board is owner of an immense fleet of steamships, which can neither be operated by it in competition with foreign vessels, nor sold to private owners on any basis permitting their operation, and which are consequently laid up in idleness; where their very existence operates as a perpetual threat against the market, keeping freight rates at their lowest level and making any revival of the ship-building industry impossible. Yet these ships represent a huge investment of the public money which cannot be abandoned as long as any hope remains of even partly redeeming it.

The Shipping Board, headed by former Chairman Benson and present Chairman O'Connor, has long realized, and has convinced Congress, that the only



hope in this situation lies in the conversion of these idle steamships into motorships, which, as is well known, can operate profitably at rates well below the profit level for steamers.

The difficulty has been that existing types of Diesel engine require so much more space and weight per hp. than the steam machinery they were expected to replace, that their installation involves expensive structural changes, and also, as a rule, the sacrifice of some of the ship's deadweight capacity for cargo, besides the very heavy first cost of the engine itself.

This problem possessed peculiar interest to the Worthington corporation, for two reasons. As the leading American Diesel engine builders, the company's engineers naturally had followed closely the development of this type of power in the field of ship propulsion. At the same time, having been for many years leading builders of marine auxiliary machinery, they were especially familiar with the special problems involved in marine engineering, and on both counts were desirous of contributing, and felt themselves unusually fitted to contribute, to the solution which the Shipping Board was seeking.

It became evident that the situation demanded a new type of engine, designed to overcome the handicaps inherent in the character of existing Diesel machinery. The problem before the Worthington engineers, therefore, was to produce an engine with all the advantages of the Diesel engine in fuel and general operating economy, but approaching, in dimensions, weight and speed per hp., closely enough to steam machinery, to permit it to be substituted for such machinery in ships already built, at no prohibitive cost either for the engine or for the job of installation.

An additional point of great importance to marine engineers was that of manoeuvring qualities. A marine engine must be capable of being started, stopped and reversed quickly, and with ease and certainty of control. In this particular is to be found one of the reasons why the reciprocating steam engine has so long held its ground in competition with both the steam turbine and the Diesel engine.

The leading collaborators in the long research now successfully concluded, were O. E. Jorgenson, a Diesel engineer of international reputation, for the past five years a member of the Worthington technical staff, and Dr. C. E. Lucke, Professor of Mechanical Engineering of Columbia University, New York.

The engine which has resulted is not only expected to form an entire solution of the marine problem which called it into being, but will undoubtedly be of the greatest interest to industrial and mechanical engineers everywhere, as the relation of space, weight and first cost to hp. is of importance in land power plants as well as in shipping. The new engine is characterized by simplicity of design and construction, and its initial cost per hp. will consequently be low.

The basic principle underlying the Worthington engine may be briefly stated to be: in the four-cycle Diesel engine one stroke in four is a power-stroke; in the two-cycle engine one stroke in two; in the new engine every stroke is a power stroke. Its working cycle, therefore, is virtually the same as that of a reciprocating steam engine.

The principle, of course, is not a novel one, but complicated heat stresses in the cylinder of a double-acting engine, have hitherto interfered with its successful application. The success of the Worthington design lies in the manner in which the problems of expansion and of heat removal are solved.

Once the major problem is overcome, the great advantages of the double-acting type are evident. The balance of the moving parts, for example, is greatly simplified, and the weight saving, not only from the manner in which the required power per cylinder is distributed through four strokes instead of being concentrated in one, but also from the decreased provision needed to care for the momentum of moving parts, and in other ways, is obviously great.

The cylinder of the new engine might be described as composed of two single-acting cylinders, opposed end for end and working in opposite directions, their respective pistons flanged to the same rod, the scavenging and exhaust ports, cooling water circulation and expansion provisions of the two being virtually independent of each other.

Once this fundamental idea of the engine is grasped, the design is seen to be quite simple, following in all respects the best modern standards in Diesel engine practice. The plan followed for insuring the

maximum strength and rigidity in the cylinder construction, combined with the necessary freedom for expansion and uniformity of heat transference, and with economy in materials, is both simple and effective.

The valve gear presents no particular novelty in design. There are three fuel spray valves, one on top of the upper end of the cylinder, and two in the bottom head on opposite sides of the piston-rod, entering at an angle. One of the admirable points of the design is the ingenuity with which these two valves are worked out so as to give a uniform and symmetrical distribution of the charge around the piston rod.

The reversing mechanism, as a point of interest, is second only to the unique cylinder design. Each of the three valves has its own cam, all three geared to the same shaft. The cams are symmetrical, and all that is necessary to reverse the running direction is to shift all three cams simultaneously through 34 deg. on the shaft.

This is accomplished by a worm shaft, which in turn is actuated by an oil-operated hydraulic mechanism controlled by a four-way cock, this in turn being operated by a single lever on the manoeuvring platform.

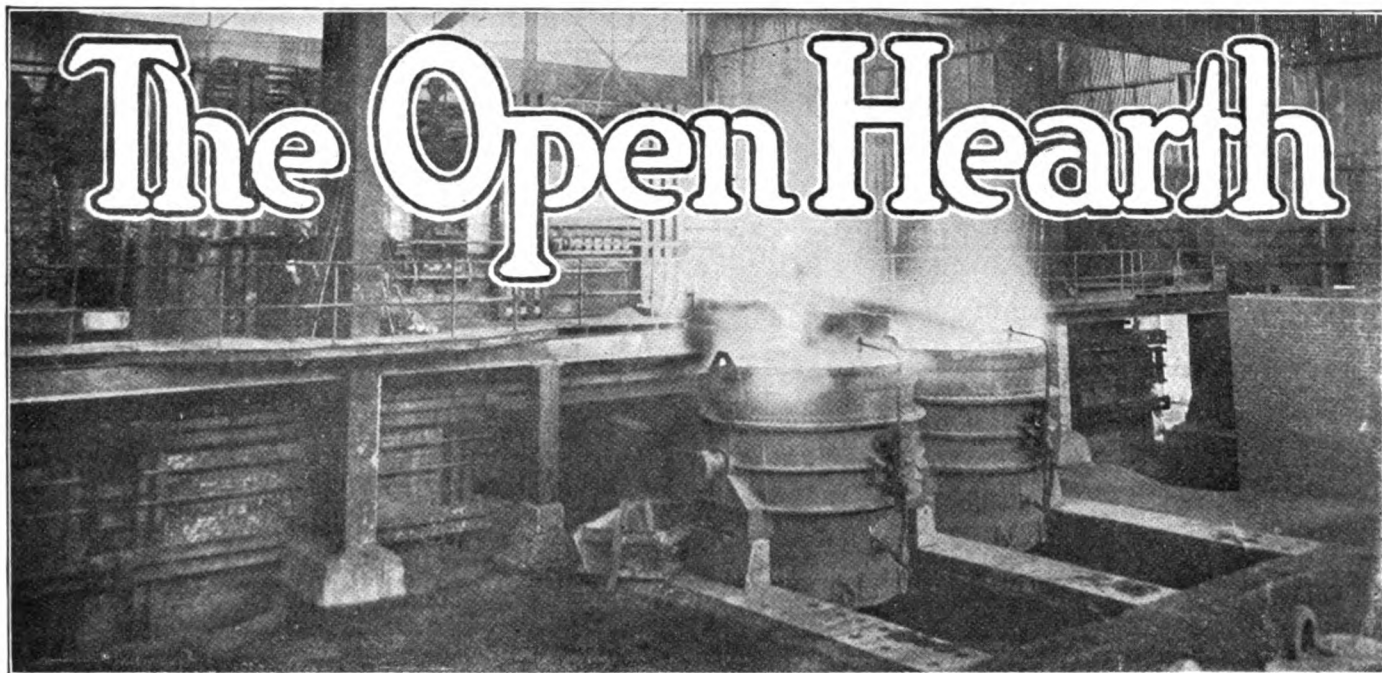
The engine is started and stopped by a single lever, which as it is moved forward successively opens the air starting valves, then the fuel supply valves, simultaneously closing the air starting valves; the lever being then capable of setting, by a ratchet and pawl, at any desired fuel supply. To stop, all that is necessary is to throw this lever back to the stop position.

The starting and stopping lever and the reversing lever, though independent of each other in all other respects, are interlocked so that the engine must be brought to a full stop before reversing. Manoeuvring control is, therefore, practically as simple and effective as that of a reciprocating steam engine, and much more prompt and efficient than that of a steam turbine. This feature, indeed, of positive quick-operating reversing gear, is expected to appeal to marine engineers almost as strongly as the more immediately obvious advantages of the new design.

Every effort has been made, in all the auxiliary mechanism as well as in the engine proper, to secure the utmost possible simplicity both in design and operation, that can be combined with the highest efficiency and reliability. Scavenging, cooling and lubrication, for example, are all believed to represent a new level of thoroughness and efficiency in Diesel engine practice, and this is typical of the engine as a whole.

Census of Manufactures, 1923

The Department of Commerce announces that, according to reports for the biennial census of manufactures, 1923, the establishments engaged primarily in the manufacture of gas and oil stoves and appliances in that year reported such products valued at \$104,174,80, together with other classes of products valued at \$8,114,947, making a total of \$112,289,797. Because of changes in the classification of this industry, the figures for 1923 are not comparable with those reported for 1921, but the rate of increase during the two-year period may be roughly estimated at 120 per cent.



Victor W. Zilen has become chief engineer of the Titusville Iron Works Company, Titusville, Pa., and the Titusville Forge Company, that city. He also is production engineer of the Buffalo Machine & Iron Corporation, Buffalo, N. Y.

H. C. Thomas, formerly vice president and assistant manager of the United Alloys Steel Corporation, Canton, O., which position he resigned last February, and for 10 years previous to that time assistant superintendent of the Indiana Steel Company's plant at Gary, Ind., has been appointed general manager of the plants of the Alan Wood Iron & Steel Company at Swedeland, Pa., Ivy Rock, Pa., and Conshohocken, Pa. Richard G. Wood, L. Hecksher, William A. Cooper and John E. Mountain will retire from active control of operations. Mr. Thomas was an assistant metallurgist at the Ivy Rock plant before he resigned to go to Gary. He recently returned from an extensive foreign trip.

T. J. Bray, president Republic Iron & Steel Company, is in Mercy Hospital, Pittsburgh, having been taken ill while in that city.

S. F. Pryor, who will succeed Harry W. Goddard as chairman of the board of the Wickwire-Spencer Steel Corporation, if the plan of reorganization is carried through, is chairman of the executive committee of the Remington Arms Company and is a director of the Air Reduction Company, Inc., American Brake Shoe & Foundry Company, American Ship and Commerce Company, Baldwin Locomotive Company, Nash Motors Company, Southern Wheel Company, William Cramp & Sons Ship & Engine Company, Merchants Shipbuilding Corporation, American Agricultural Chemical Company and various other corporations. He has been vice president of the Union Pacific Railroad, vice president of the Simmons Hardware Company; in charge of the railway supply department and president of the Southern Wheel Company.

Messrs. Vickers Limited have just installed at their Barrow-in-Furness works a new open-hearth Siemens steel furnace of the very latest type, built and designed by Messrs. Wincott's, of Sheffield. The capacity is between 10 and 20 tons per heat, and it is now possible to get a total output from the steel foundries at the Barrow works up to 300 tons of castings per week, ranging from a few pounds weight each to a 20-ton casting. Casting to Admiralty, Lloyd's, and Board of Trade requirements, such as ship's structural work, can now be made at the Barrow works up to the above figures. In addition, it is anticipated that a good proportion of the output will be absorbed for commercial castings. The first heat was tapped from this furnace on the 18th ult., with very successful results, as determined from the test figures and analyses, and it will now be possible for Messrs. Vickers Limited to give special attention to inquiries for steel castings of every description up to 20 tons weight.

Frank C. Roberts, consulting engineer, Philadelphia, much of whose work has been in the design and construction of blast furnaces and of important industrial and power buildings, was given the honorary degree of doctor of engineering by Princeton University at its last commencement.

B. D. Quarrie has resigned as general manager and director of the Otis Steel Company, Cleveland. No appointment will be made to fill his place. He has been with the Otis Company about two years and was previously general superintendent of the blast furnace and steel works of the American Steel & Wire Company in Cleveland.

Thomas J. Rossiter has resigned as superintendent of the Salem, O., plant of the American Steel & Wire Company and has been succeeded by Robert C. Garrison, who has been assistant superintendent of the H. P. Works in Cleveland. Mr. Rossiter has been in poor health for some time. After his recovery he probably will re-enter the employ of the company in some other capacity.

Some Pointers on By-Product Coke Oven Operations

Abstracts of Papers, Fall Meeting of American Chemical Society, Ithaca, N. Y.

Principles of Gas Absorption.

By W. K. LEWIS and W. G. WHITMAN

The rate of absorption is generally determined by the rate of diffusion through the gas-liquid boundary separating the two phases. The mechanism parallels that of heat transfer and the same equation may be applied to both processes:

Rate of transfer = rate coefficient $\times$ area $\times$ potential gradient.

With gas of low solubility (O_2 and CO_2 in water) diffusion through the surface film of liquid is slow because only small concentration gradients for diffusion can be established. The liquid film resistance is therefore so large that the resistance of the gas film is negligible and the rate is controlled entirely by diffusion through the liquid. With very soluble gases (HCl from air into pure water) the reverse is true—large concentration gradients are possible across the liquid film, its resistance therefore becomes negligibly small, and the rate is controlled by diffusion through the gas to the liquid surface.

Certain methods of securing contact between liquid and gas give very thin liquid films whereas others tend to disrupt the gas film. These characteristics vitally affect the suitability of different types of equipment for specific purposes.

The Mechanism of Absorption of Moderately Soluble Gases in Water.

By H. G. BECKER

Data on the absorption of oxygen and nitrogen by water from gas bubbles and also through the upper surface of a stirred liquid show that the absorption rate is proportional to the degree of unsaturation. Data on the effects of temperature and of rate of stirring are presented. The rate obtained with a gas bubble was more than double the maximum rate obtained through a stirred liquid surface.

In other experiments absorption rates for gases of widely varying solubilities have been determined through a quiescent water surface. The results show that absorption under these conditions is a complex phenomenon, that stratification of the liquid occurs, and that the nature of the gas and its effect on the density, surface tension and viscosity of the water are determining factors.

Gasoline from Natural Gas VI, the Role of Absorption In Its Production.

By R. P. ANDERSON

This paper is devoted to a discussion of the oil and charcoal processes for the recovery of gasoline from natural gas, emphasizing the relationship between the efficiency of absorption of the gasoline vapor from the natural gas and the efficiency of condensation of this same gasoline vapor from the gas mixture liberated from the absorbent on distillation.

The development of the process of stabilization of natural gas gasoline and its relationship to the previous problem are also discussed.

The Absorption of Carbon Dioxide and Ammonia from Gas Bubbles.

By PAUL G. LEDIG

By the use of a method described in a previous paper, a study has been made of the rate of absorption of carbon dioxide by potassium hydroxide solutions of various concentrations. A comparison is made between the rates for these solutions and the rates previously obtained for sodium hydroxide solutions. Also a preliminary series of studies has been made on the rate of absorption of ammonia by ammonium hydroxide solutions of various concentrations, using an adapted form of the same apparatus.

Comparative Absorption Rates for Various Gases.

By W. G. WHITMAN and D. S. DAVIS

Absorption rates for O_2 , NH_3 and HCl into a stirred water surface have been determined. The results accord with the theory that the rate of absorption for gases of low solubility is controlled by liquid film diffusion, whereas the rates for very soluble gases are limited by diffusion through the gas. From the results with O_2 (the least soluble gas) and HCl (the most soluble) it is possible to predict rates for SO_2 and NH_3 which show good agreement with the data.

Data are presented showing that the specific rates of deabsorption for SO_2 and for NH_3 from water are approximately the same as those for absorption. Other experiments show the effect of speed of stirring and of viscosity of liquid on the rate of deabsorption for SO_2 .

Absorption of Hydrogen Sulphide.

By F. W. SPERR, JR.

The purification of coal gas and water gas from hydrogen sulphide is of great importance to the artificial gas industry. Until recently, this was accomplished by dry absorbent material, generally by hydrated iron oxide. The use of a dry purification material has a number of practical disadvantages, so a great many attempts have been made to develop a liquid process. However, until within the last few years no liquid process had proven a practical success.

A few years ago The Koppers Company developed a liquid process for the absorption of hydrogen sulphide which has proven very successful. About 25 plants in America are now employing this process and a number of new installations are being made. This process employs as an absorbing medium a dilute solution of sodium carbonate. The hydrogen sulphide is removed from the soda solution by aeration, thus regenerating the solution which is used over and over again.

The process can be used for complete purification, but it is usually preferred to remove 85 to 90 per cent of the hydrogen sulphide by the liquid process, the remainder being taken out in iron oxide catch boxes. Besides removing hydrogen sulphide, the process has been found valuable in removing over 90 per cent of the hydrocyanic acid, which is an objectionable constituent of coal gas, and which is not satisfactorily removed by dry purification.

(To be continued in October)

NEWS OF THE PLANTS

The Belfort Steel & Iron Company, Blanton, R. F. D., Ironton, O., has preliminary estimates of cost under way for a number of additions in its plant to provide for extensive increase in capacity. The work as now projected will include a new rolling mill, rod mill, wire mill and other structures. Arthur G. McKee & Company, 2422 Euclid Avenue, Cleveland, O., are engineers. I. P. Blanton has recently been elected president of the company, succeeding S. Coles Peebles.

The Penn Seaboard Steel Corporation, Franklin Bank Building, Philadelphia, Pa., is said to have plans under advisement for extensions and improvements at its plant at New Castle, Del., to consist of the installation of additional furnaces and accessory equipment, estimated to cost in excess of \$500,000, including machinery. It is expected to proceed with the work at an early date.

The Bethlehem Steel Corporation, Bethlehem, Pa., has plans for the construction of a new power house at its Cambria works, Johnstown, Pa., estimated to cost about \$200,000, including equipment. The work will be carried out in connection with the adopted program of expansion at the plant, including blast furnace improvements and other alterations. A contract has been let to Arthur G. McKee & Company, 2422 Euclid Avenue, Cleveland, O., engineers and contractors, to install electric ball operating rigs on blast furnaces No. 10 and 11 at the plant. Orders for other work, including equipment, will be placed in the near future. The company is advancing operations at its different mills, following curtailment for a number of weeks past, and has resumed work at its rail mill at the Steelton, Pa., plant, to operate on a single turn each day until further notice; it is expected to blow in two blast furnaces at the plant at an early date.

The Tidewater Steel Corporation, 149 Broadway, N. Y., has purchased a tract of property near Hagerstown, Md., comprising about six acres of land, and has plans under way for the construction of a new plant to occupy a portion of the site for the present, and ultimately the entire tract. The first building will be 65x300 ft., 1-story, and will be equipped largely as a steel fabricating plant.

The Toledo Furnace Company, Toledo, O., has work in progress on additions and improvements at its plant to provide for considerable increase in production, as well as permit greater efficiency in operation. The company will replace one of its furnaces with a new unit of thoroughly modern type. A new pig-iron mill will be erected, and extensions made in the reinforced concrete dock at the plant. A new intake water system will be installed, and other work handled to improve this branch of the works. The entire project will involve in excess of \$2,500,000, and will require several months for entire completion. The Barret Company, Chicago, Ill., is general contractor for the work.

The Witherow Steel Company, Pittsburgh, Pa., will make a number of extensions and improvements in its plant, to include the installation of a large car

hearth annealing furnace and accessory equipment, for which a general contract has been awarded to F. J. Ryan & Company, Philadelphia, Pa. The new furnace unit will be 34 ft. long, 12 ft. wide and 6½ ft. high, with capacity of 75 tons on the car.

The Delaware River Steel Company, Chester, Pa., has plans under way for expansion and betterment at its works, primarily to the blast furnace, including the installation of a new furnace top, skip hoist, with trestles, bins and auxiliary equipment. It is expected to proceed with the work at an early date.

The United States Steel Corporation, New York, is reported to be considering plans for the rebuilding of its blast furnace at Gary, Ind., recently destroyed by fire caused by a gas explosion. The stack had been out of commission for a number of weeks and was being relined and repaired at the time of the disaster, which caused other property loss at the plant reported in excess of \$500,000.

The Punxsutawney Furnace Company, Punxsutawney, Pa., will soon commence the installation of additional equipment for general improvements at its blast furnace, and for which a general contract has been given to Arthur G. McKee & Company, 2422 Euclid Avenue, Cleveland, Ohio. The work will include the construction of a double track steel trestle, coke and ore bins, transfer and car equipment and miscellaneous apparatus.

The American Puddled Iron Company, Youngstown, O., which commenced operations several months ago at a new mill at Warren, O., under a special mechanical process, will make a number of improvements and alterations in the plant, including the installation of additional equipment, as well as relocation of existing machinery. The plant has been closed down until fall to allow for the changes and is expected to resume just as soon as the work has been completed.

The American Sheet & Tin Plate Company, Frick Building, Pittsburgh, Pa., has completed plans for the erection of a new building at its Canton, O., plant to be 1-story, estimated to cost \$65,000, including equipment. It is proposed to begin work at an early date.

The Kalman Steel Company, Mutual Life Building, Buffalo, N. Y., has preliminary plans under way for additions in its plants at Youngstown, O., and Blasdell, N. Y., used primarily for the production of rods for concrete reinforcement. The expansion is reported to involve in excess of \$150,000, including equipment at the two mills and will be placed in progress at an early date.

Officials of the Atlas Steel Corporation, Dunkirk, N. Y., are arranging for the early reorganization of the company, now in receivership, and the resumption of operations at the local mill, in which a number of changes and improvements are proposed. H. E. Nichols is receiver for the company, in charge.



Positions Wanted and Help Wanted advertising inserted under proper headings free of charge. Where replies are keyed to this office or branch offices, we request that users of this column pay postage for forwarding such replies. Classified ads can be keyed for the Pittsburgh, New York or Chicago offices.

POSITION WANTED

MELTER, 18 years practical experience. Open Hearth and Electric, leading European makers high grade steels, age 35, wants position where his knowledge and experience can be used. Highest references. Box 301, care of The Blast Furnace and Steel Plant.

POSITION WANTED—Cold strip mill superintendent with thorough knowledge in operating. Can apply latest methods to produce highly finished material. Twenty years' experience; reliable references. Box 000, care of The Blast Furnace and Steel Plant.

MASTER MECHANIC with 30 years' experience on construction and operation of steel mills, blast furnaces, open hearths, Bessemer departments, by-product coke plants; constructed hydro and steam electric plants, large pumping stations, etc.; at present employed, wish to make change. Box 100, care of The Blast Furnace and Steel Plant.

CHIEF DRAUGHTSMAN—Broad and varied experience in general engineering, mechanical, structural, electrical, designing machinery, tools, power, structural steel, concrete and industrial buildings; purchase, installation and plant maintenance. Address Box A M B, care of The Blast Furnace and Steel Plant.

DESIGNING ENGINEER, experienced executive with technical training, desires position as chief engineer or master mechanic. Fifteen years' experience, including design and construction of rolling mills, furnaces, plant equipment, power plants, special machinery, etc.; four years in machine shop. Address Box F C M, care of The Blast Furnace and Steel Plant.

POSITION WANTED—A graduate mechanical engineer with 12 years' experience in rolling mills, desires a position as superintendent or assistant. Experience covers every job in a rolling mill from laborer to assistant superintendent. Also has had some office and sales training. At present employed, but desires a better outlook. Box C A S, care of The Blast Furnace and Steel Plant.

POSITION by chemist, technical graduate. 15 years experience glass, animal fats, bleaching iron and steel. Six years experience as plant executive. Research work a specialty. Box L, care of The Blast Furnace and Steel Plant.

YOUNG rolling mill superintendent with 20 years' practical experience on iron and steel Belgian type mills, also latest continuous type steel mills, desires to make change. Can furnish records and references. Have practical knowledge of rolling and roll designing. Box F A W, care of The Blast Furnace and Steel Plant.

ENGINEER, Cornell graduate, seven years' steam and fuel engineering, three years' executive experience as master mechanic of a rolling mill, three years' sales engineering, desires change. Box S, care of The Blast Furnace and Steel Plant.

PLANT ENGINEER or assistant to general manager. A graduate mechanical engineer, with broad training and experience is available for position requiring ability and hard work. Box F, care of The Blast Furnace and Steel Plant.

POSITION WANTED

ENGLISHMAN, 23, of sound general and technical educations, with seven years' experience of steel making by open hearth process (acid and basic) in prominent English steel works, desires appointment where scientific and practical knowledge would be an asset. Box G B J, care of The Blast Furnace and Steel Plant.

WANTED—A position wherein the following will be of value: A fair technical education, a large amount of practical experience in the various mechanical arts and plant operation and maintenance with an eye on the "works operating expense" account, a fair degree of executive ability and absolute dependability. Experience has been had in production and general machine shops, rolling mills, rod and wire mills and at blast furnaces. Expert in design and construction of the Dwight and Lloyd type of sintering plant. Box C C C, care of Blast Furnace and Steel Plant.

CHEMICAL ENGINEER, 1922 graduate, leading university, desires position in a steel plant. One year's experience in the inspection department. At present employed, but available on short notice. Box J B C, care of Blast Furnace and Steel Plant.

POSITION WANTED—Electric furnace man open for position; experienced on basic Heroult electric furnaces, tool and alloy steels. Box A T, care of The Blast Furnace and Steel Plant.

WITH experienced consulting mining engineer; will go to any country. Speak French and Spanish. Box M, care of The Blast Furnace and Steel Plant.

HEATER on soaking pits or reheating furnaces; 10 years' mill experience; can give references. Box C Z, care of The Blast Furnace and Steel Plant.

SALES POSITION with manufacturers' sales agent for power plant specialties or chief draftsman or plant engineer with moderate sized manufacture. Box K, care of The Blast Furnace and Steel Plant.

I DESIRE to have a position as tracer or on small drafting work with reliable concern, preferably in mechanical line. Box J, care of The Blast Furnace and Steel Plant.

YOUNG MAN, technical graduate and 7 years' practical experience, would like to connect with organization needing a producer. Prefers a job which keeps him on the road the major portion of the time. He has intensive education along lines of general inspection of materials. Box I, care of The Blast Furnace and Steel Plant.

POSITION as field engineer, construction work, general survey work and right-of-way work. Box G, care of The Blast Furnace and Steel Plant.

POSITION WANTED by chemical engineer, degree of doctor-engineer (1916) from leading German university, 33 years old, six years' experience embracing the analysis, metallography and physical testing of steel and alloys. Nationality, Norwegian. Languages, Norwegian, Swedish, German and English. Location, anywhere. Available, any time. Can furnish best of references. Box R E D, care of The Blast Furnace and Steel Plant.

TIME KEEPER—Have had several years experience. Box H, care of The Blast Furnace and Steel Plant.

POSITION WANTED

CHIEF CLERK or assistant to works manager; 32 years old, married. Ten years' experience in sheet and tin rolling mills, galvanizing, long terne and factory record and office work. Experienced from time-keeping to corporation yearly statement, including cost. Box L E T, care of The Blast Furnace and Steel Plant.

ROLLING MILL superintendent, experienced in the heating and rolling of carbon, alloy and electric furnace steels, desires position; experienced in blooming, plate and universal mills. Highest references. Box A R T, care of The Blast Furnace and Steel Plant.

YOUNG MAN with five years' experience as machinist and three years' experience in foundry. Tech graduate, wishes position with growing firm at or near Philadelphia, Pa. Box W B, care of The Blast Furnace and Steel Plant.

POSITION WANTED by experienced roll turner and designer. Have had several years' experience in charge of roll shops, designing, etc., as well as turning rolls. Have also had experience working on the mills. Can handle position of mill superintendent, roll designer or boss roll turner. Can furnish best of references. Box P V C, care of The Blast Furnace and Steel Plant.

POSITION WANTED—Steel mill electrical engineer desires change in location. Five years' engineering and operating experience in steel mills. Technical graduate, member A. I. & S. E. E., Associate A. I. E. E.; age 32. Box A R L, care of The Blast Furnace and Steel Plant.

YOUNG MAN, technical education, desires position in Pittsburgh District as chemist on analysis of open hearth steels. The applicant is at present employed in steel work, but desires a connection offering greater possibilities. Details as to past experience and recommendations will be submitted on request. Box G P G, care of The Blast Furnace and Steel Plant.

WANTED—Position on maintenance in medium sized steel plant or factory; 12 years' drafting room experience on general mill engineering and three years' machine shop experience. Box F D J, care of Blast Furnace and Steel Plant.

POSITION WANTED—Blast furnace superintendent, twelve years practical experience as blast furnace master mechanic, general foreman and assistant superintendent, thoroughly familiar with metallurgy of iron, maintenance of plant, Bessemer, foundry, Spiegle, ferro silicon and ferro manganese, also up-to-date in best cost practice, technical education; employed at present. Address Box F W H, care of The Blast Furnace and Steel Plant.

PHOTOGRAPHER—Thoroughly competent to take charge of photographic department in industrial concern; experienced steel mill man; reference furnished. Address Box C B S, care of The Blast Furnace and Steel Plant.

FIELD ENGINEER, desires change. Technical training and nine years experience on construction and maintenance of steel plants; also general surveys; 30 years old and married. Box 200, care of The Blast Furnace and Steel Plant.

POSITION WANTED—Assistant superintendent open hearth or bloom mill. Have had quite a number of years' experience in open hearth and bloom mill practice, believe in quality steel and can furnish best of references. Box T, care of The Blast Furnace and Steel Plant.

Co-operate:—Refer to The Blast Furnace and Steel Plant

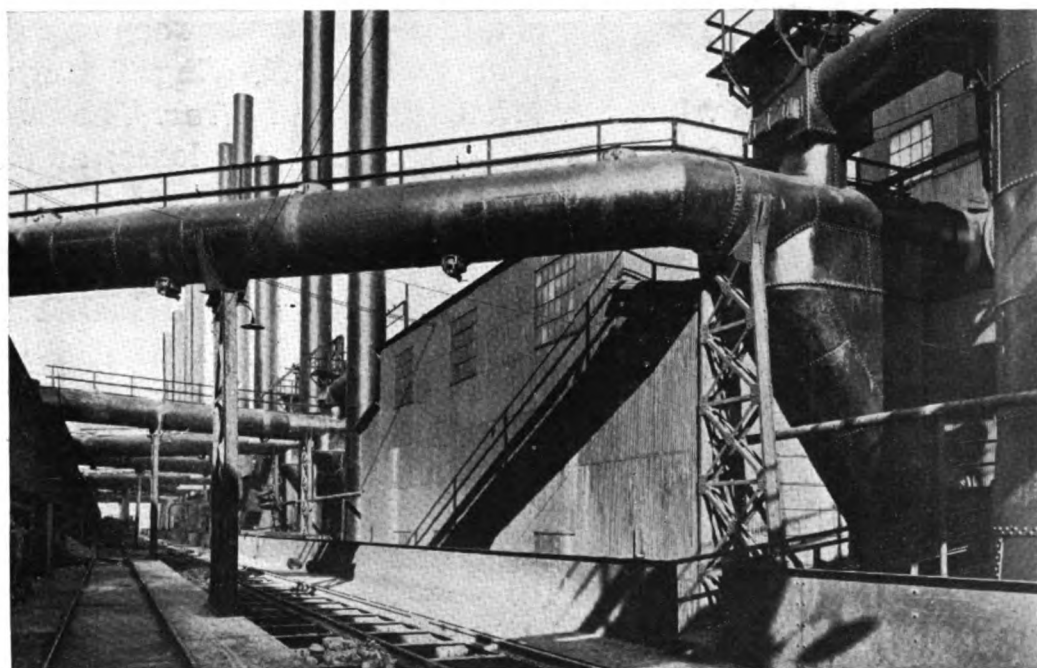
The Blast Furnace *(and)* Steel Plant

Member of the Audit
Bureau of Circulations

PITTSBURGH, PA., SEPTEMBER, 1924

Entered as second class mail matter at Pittsburgh,
Pa., under the act of Congress, March 3, 1879

MORGAN OF WORCESTER PRODUCER GAS MACHINES COMPLETELY AUTOMATIC



This Picture represents the Gas Flues and
Trackage between Open Hearth Building and
Gas Houses at one of the leading Ohio Steel Plants
where 35 Morgan Producer Gas Machines are in service.

MORGAN CONSTRUCTION CO.
WORCESTER, MASS. U.S.A.
PITTSBURG OFFICE 610 MAGEE BLDG